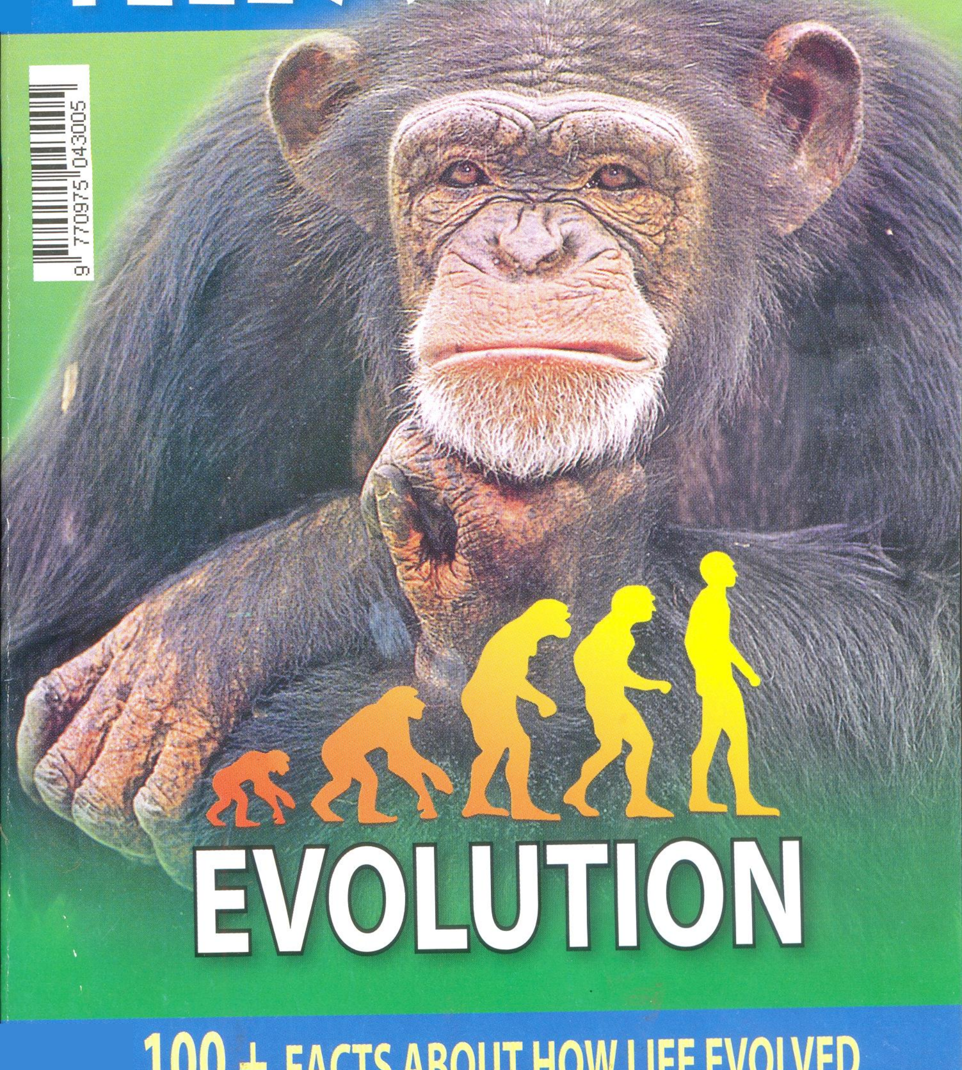
MANORAMA

No. 65

TELL ME WHY



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MANORAMA
TELL ME WHY

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Where The Fittest Survive

We usually refer to Earth as Mother Earth. In fact, our Earth is a great, great, great grandma, whose age is calculated as being over 4.5 billion years! As with all old people, Earth too, has gone through different stages in its life, some very difficult, and some very pleasant. During its early years, the Earth was too hot for any living thing to exist on it. After millions of years, it cooled down, and heavy rains started to fall. Gradually, water began to fill the lower depressions, forming the oceans, which became the cradle of life.

Life began in water more than two billion years ago. From simple beginnings, life gradually acquired more complex forms. Such changes are together known by the term evolution. Obviously, the most important result of the evolution of life is the human being. Human beings are two million years old, and that means we can be called the latecomers. But humans have already had a greater influence on Earth than any other living being. This issue of Tell Me Why tells you the great and exciting story of evolution.

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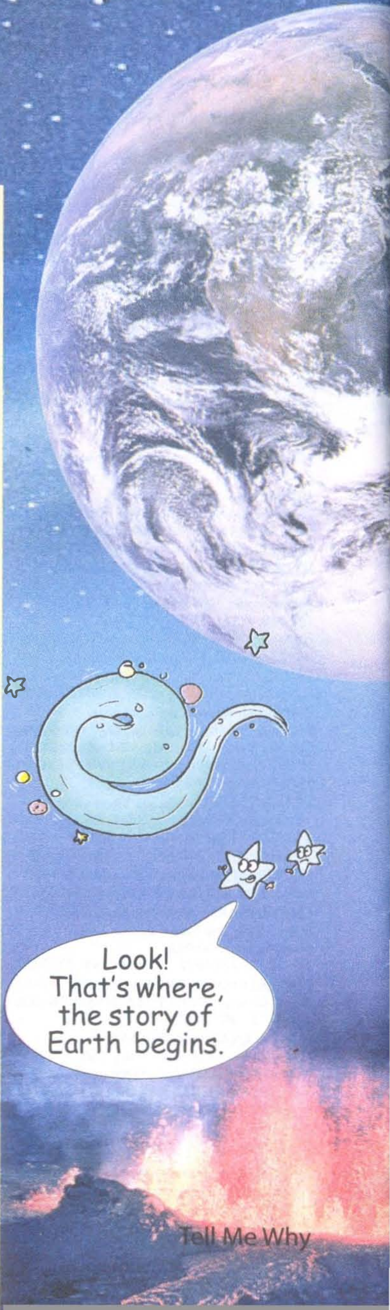
LIFE ON EARTH

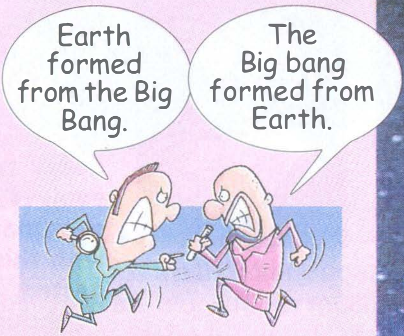
Why do we say that the beginning of the Earth can be traced to the Hadean Period?

The Hadean Period started when the Earth was formed about 4.5 billion years ago. During Hadean times, the Solar System was forming, probably within a large cloud of gas and dust around the sun. The sun was formed within such a cloud of gas and dust. The tendency of matter to clump together, finally resulted in the formation of substantial bodies like the planets, and their moons.

The oldest Earth rocks and Moon rocks we know about, both date to this time. Water was brought to Earth by comets that crashed into the Earth. This water boiled into steam, because the Earth was still very hot, and formed a steam atmosphere around the Earth. As the Earth cooled down, about 4.3 billion years ago, the steam in the atmosphere also cooled down, and fell as rain on the Earth, and that made the oceans. By 4.2 billion years ago, Earth had land and oceans.


Look! That's where, the story of Earth begins.

How did the Earth come into existence?


Earth formed from the Big Bang.
The Big bang formed from Earth.

From the beginning of time, human beings have wondered how the Earth came into existence. Different religions have different versions, while scientists too, give many different explanations. Scientists claim that a vast, dark, very hot cloud of dust swirled around a newly formed sun. Gradually, the cloud cooled, and the gas began to condense into billions of droplets. Slowly, these droplets were pulled together into clumps by their own gravity-and they carried on clumping until all the planets, including the Earth, were formed. In short, scientists and researchers have been arguing for centuries about how the Earth was formed, and the debate still continues.

Spotted Salamander

Salamanders

In ancient times, people often found a mysterious animal crawling out from under a burning log, unscathed. Amazed, they gave this animal a Greek name, 'salamander'. They believed that salamanders were born from the flames. However, the fact is that these creatures live under logs. Hence, when they were seen emerging from flaming logs, they were really running for their lives!

Alfred Wallace

STARFACT

Ape or Angel?

There is strong evidence to suggest that human beings evolved from ape-like ancestors. However, many people were not comfortable with this idea. So, a compromise suggested by Alfred Wallace was that though man evolved from apes, his spirit came from a supernatural force.

Why are scientific theories different from traditional beliefs?

Scientists work by studying the evidence collected, looking for new evidence by questioning existing theories, and trying to develop better ones. Traditional beliefs are a matter of faith. They are not open to question or to change, while scientific theories are. Scientific theories can be tested by using them to make predictions, and then checking whether these predictions come true.

Some scientific theories include the theory of evolution, the theory of relativity, the atomic theory, and the quantum theory. All of these theories are well documented, and proven beyond reasonable doubt. Yet, scientists continue to tinker with them in an attempt to make them more elegant and concise, or to make them more all-encompassing.

Help me! My life is in danger!
LIFE TO EARTH

How did life originate on Earth?

Earth is estimated to be about 4.5 billion years old, and for much of that history, it has been home to life in one form or another. Today, there are several theories for how life arose on Earth. The first of these is that life was created by a Supreme being or spiritual force. The second theory is that life began in another part of the Universe, and arrived on Earth by accident when a comet or meteor crashed.

Scientists say that life began around 3.5 billion years ago as a result of a complex sequence of chemical reactions that took place spontaneously in the Earth's atmosphere. Molecules were formed as a result of these reactions. The molecules then interacted with one another, and this eventually led to the earliest forms of life.

The first beings were probably bacteria which survived on naturally occurring food, and did not breathe oxygen. The fossils of these oldest forms of life have been found in Australian rocks dating back 3.5 billion years.

Why have fossils given rise to many myths?

Fossils are the remains of animals or plants which once lived on the Earth millions of years ago. When fossils were first discovered, people did not really understand what they were, and so, many myths and folklore developed over time, about where fossils came from.

The coiled shells of some fossils led the Ancient Greeks to believe they were related to the ram-god Ammon. In China, these were also thought to resemble horns, and were called 'horn stones'. In England, they were believed to be coiled snakes that had somehow lost their heads, and turned to stone. Echinoids, also known as sea urchins, are amongst the most commonly found fossils. In some places, they are considered to be snakes' eggs, which have the power to protect one from deadly poisons.

Found a headless stone snake, sir!

Ammonite Fossils

Fire Eating Dragons

Over 40,000 years ago, giant bears roamed over Europe. Some of them were buried in caves while hibernating, and over hundreds of years, their bodies turned into fossils with huge canine teeth. When these fossils were discovered in the Middle Ages, they were thought to be the remains of a mythical creature, the fire breathing dragon.

A Paleontologist at work

Why is paleontology important in the study of evolution?

Paleontology is the study of fossils. Paleontology has played a key role in developing the theory of evolution.

The study of fossils has shown that the animals and plants of prehistoric times were very different indeed from the animals and plants of today.

By reassembling fossil bones, scientists can get an idea of the size and shape of the creatures that inhabited the Earth before the appearance of humans.

Teeth and shells that have been fossilized also tell us much about the lifestyle of these creatures. Fossils of insects are often found embedded in amber, which is a transparent rock nodule formed when the resin from trees petrifies. Small creatures are sometimes trapped inside the amber, and are perfectly preserved to give us a glimpse of ancient insects.

Trace fossils are also important in the study of evolution. Trace fossils are tunnels, worm casts and tracks that animals have made on soft sediment that has later hardened into rock. These imprints of animals on the move reveal much about the lives of ancient species, including their size, gait, stride length, and speed.

Don't lick it! This is not just a bone, but a fossil!

Missing Fossils

The most common fossils are those of sea and river creatures. Fossils of land animals are rare. This is because fossils do not form easily on land. Exceptions to this are unusual places such as caves.

Eocene Fossil Fish

Silurian Fossil

How are fossils formed?

Fossils form when an animal or plant dies in water or nearby places. The water insulates the remains from many of the elements that contribute to decomposition. For example, when an animal has died of old age at the bottom of the sea, bacteria consume the soft body parts, but leave the hard exoskeleton intact. As time passes, sediments bury the exoskeleton. As the sediments continue to pile on, the lower layers become compacted by the weight of the layers on top. Over time, this pressure turns the sediments into rock.

As the continental plates move around the Earth, crashing into each other, mountains are formed. Former sea floors are lifted up, and become dry land. Thanks to the movement of the plates, fossils will come closer to the surface, and nearer to discovery by some fortunate fossil hunter. Fossils are finally revealed through the forces of erosion.

Though there are millions of fossils that have been discovered, and millions more waiting to be discovered, fossilization is a rare occurrence. Soft bodied animals and plants that have no woody parts are rarely fossilized.

Nautilus Shells

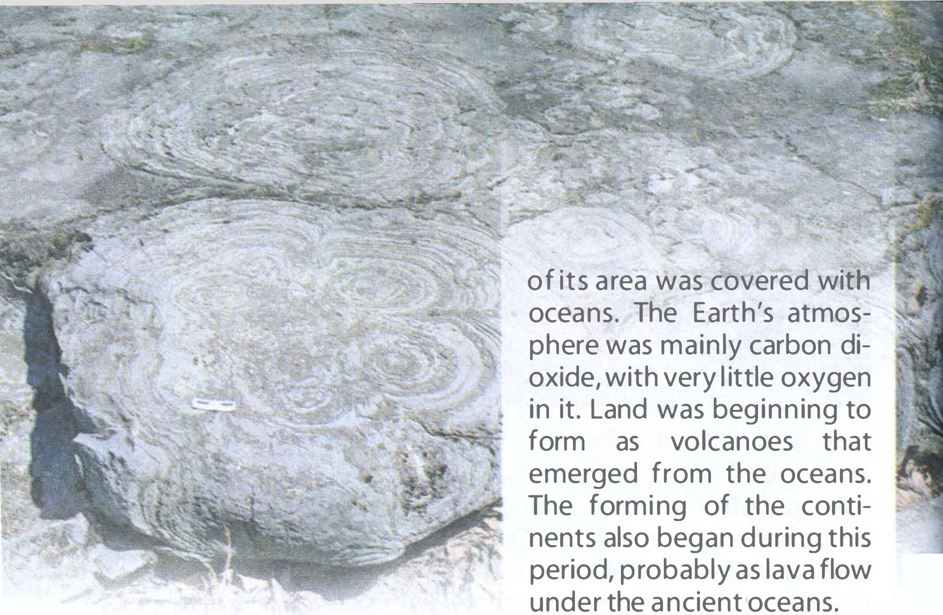
How are fossils interpreted?

People often think of fossils as being mineralized bones or shells stored in museums. However, they can even be any remains or traces of ancient organisms. They can even be footprints, burrows, or casts of bodies, with nothing else surviving. Interpreting fossils is sometimes like solving a jigsaw puzzle.

One of the ways of interpreting a fossil is to compare the fossil with the skeleton of a living creature that seems to resemble it. For example, there are many well preserved fossils of coiled shells of ammonites, which are an extinct group of marine animals with no backbone. However, the soft body parts of these animals have not been preserved. But the fossils can be reconstructed, because a modern marine species known as the nautilus is very similar to the ammonites. So, in this case, interpretation is possible.

When only one or two skeletons of a species have been discovered, there is no way of interpreting them correctly. For example, in the case of a dinosaur fossil, what was once interpreted as being a horn is now believed to be a large pointed thumb. So, until many similar specimens have been found, it is unwise to attempt a species description.

Nautilus



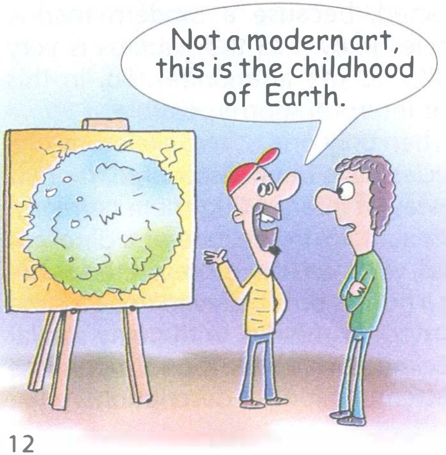
Stromatolites

What is the Archaean Period?

The Archaean Period lasted from 3800 to 2500 million years ago. The Earth was still about three times as hot as it is today, and most of its area was covered with oceans. The Earth's atmosphere was mainly carbon dioxide, with very little oxygen in it. Land was beginning to form as volcanoes that emerged from the oceans. The forming of the continents also began during this period, probably as lava flow under the ancient oceans.

About this time, the earliest living cells formed on Earth. These cells all lived in the oceans. One type of bacteria present then was the cyanobacteria, or blue-green algaes. These bacteria appear to have had a very strong cell-wall, and the ability to form layers in the ancient sediments. The formations are called stromatolites. They can be found in Archaean rock formations of Western Australia.

So to sum up, the Archaean Period was a time of continent-building, and the first stages of early life can be traced back to this period.


Not a modern art, this is the childhood of Earth.

Proterozoic Stromatolites

Why is the Proterozoic Era important?

The Proterozoic Era was between 2.5 billion and 542 million years ago. One of the most important events of this era was the gathering of oxygen in the Earth's atmosphere. Near the end of the Proterozoic Era, about 600 million years ago, creatures with more than one cell, like hydras, jellyfish, and sponges lived in the oceans. About 550 million years ago, these creatures evolved into flatworms, then round worms, and finally, into segmented worms. Thus, it was during this period that the first multi-cellular organisms came into existence.

It was during the Proterozoic Era that fiery formation processes of the Hadean and the undersea continent-building of the Archaen, were replaced by the process of plate tectonics. As a result, a single super-continent formed. Today, it is called Rodinia.

Raising Rocks

Do you know why you sometimes find sea shells on top of rocks? It is because most sedimentary rocks were once found under the sea. Animals that were buried in the sediment became fossilized. Later, movements of the Earth's crust resulted in the sea bed being pushed upward, and rocks that had been under the sea now became mountain tops.

Johann Jakob Scheuchzer

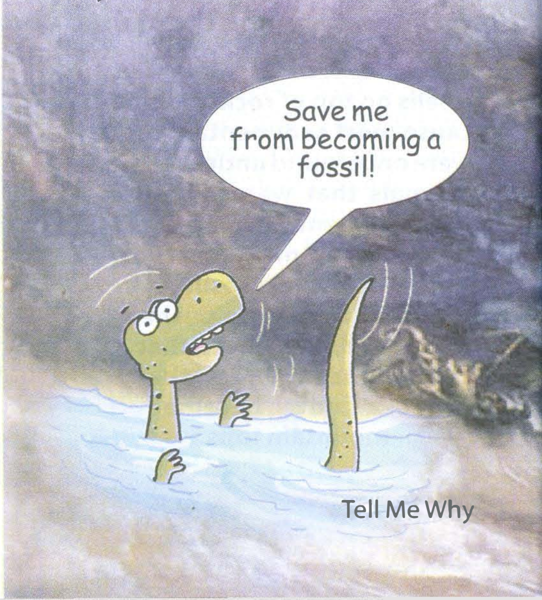
STARFACT

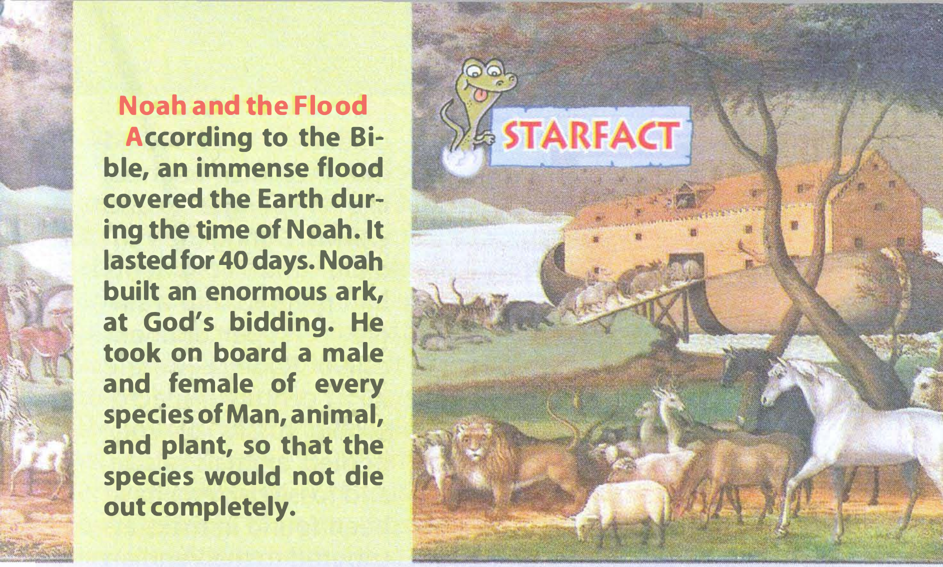
Fossil Hunter

Johann Jakob Scheuchzer was a Swiss naturalist and fossil hunter. He believed that the Great Flood created all sedimentary rocks and fossils. In 1725, he examined what he believed were the fossilized human remains of a victim of the Deluge. However, it was actually the fossil of a giant salamander. Scheuchzer was responsible for laying the groundwork for the science of fossils.

Why are fossils related to the Great Flood?

You must all have heard about the Great Flood that swept across the earth in ancient times. Many people believe that thousands of animals that were swept away by the flood, eventually became fossils. It is true that conditions during the flood were ideal for 'fossilizing' millions of animals, plants, and even dinosaurs. In fact, thousands of dinosaur bones can be found where they were washed together by violent flood waters and buried under mud, sand and rock. Many of the animals were torn apart, and their bones broken and jumbled-up. The mud and sands hardened like concrete to form the great layers of fossil rocks we find today.

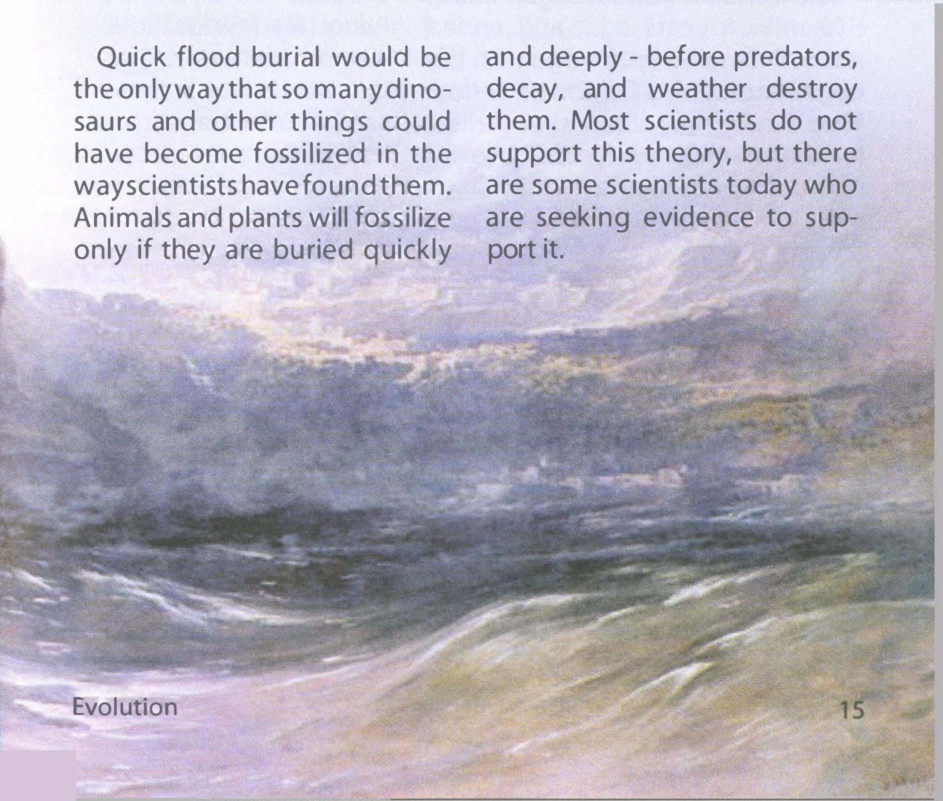

Save me from becoming a fossil!



STARFACT

Noah and the Flood

According to the Bible, an immense flood covered the Earth during the time of Noah. It lasted for 40 days. Noah built an enormous ark, at God's bidding. He took on board a male and female of every species of Man, animal, and plant, so that the species would not die out completely.

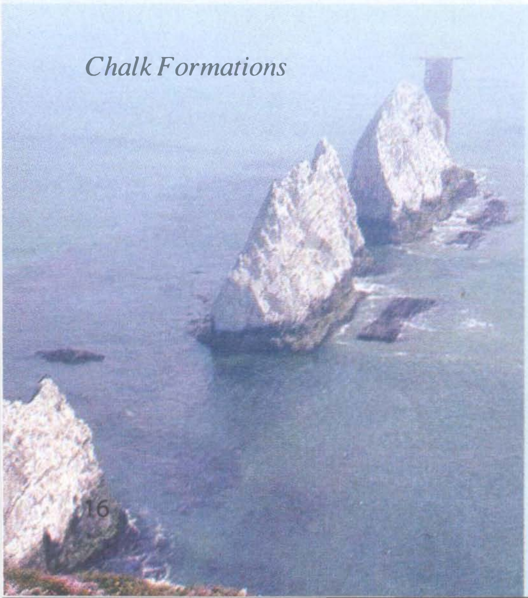


Quick flood burial would be the only way that so many dinosaurs and other things could have become fossilized in the way scientists have found them. Animals and plants will fossilize only if they are buried quickly and deeply - before predators, decay, and weather destroy them. Most scientists do not support this theory, but there are some scientists today who are seeking evidence to support it.

Sponge

Why is the Vendian Period important?

The Vendian Period began about 650 million years ago, and ended about 543 million years ago with the beginning of the Cambrian Period. The Vendian is when the earliest known animals evolved. These included soft-bodied multi cellular animals, like sponges and worms. During the Vendian, the continents had merged into a single supercontinent called Rodinia. In the 20th century, macroscopic fossils of soft-bodied animals, algae, and fossil bacteria have been found in rocks attributed to the Vendian Period in a few localities around the world. The Vendian is also known as the Ediacaran or as the Proterozoic.



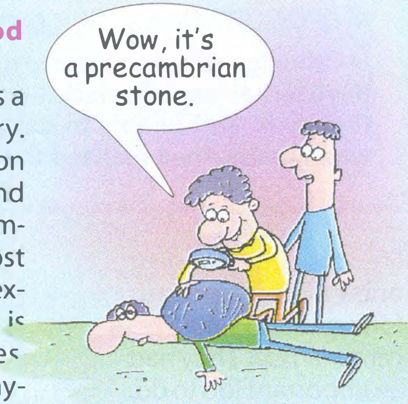
Chalk Formations

STARFACT

Rock of Ages

Did you know that chalk is almost entirely made up of tiny shells? These shells once belonged to microscopic animals that floated on the ocean's surface. They can form layers that over the ages, become towering chalk cliffs!

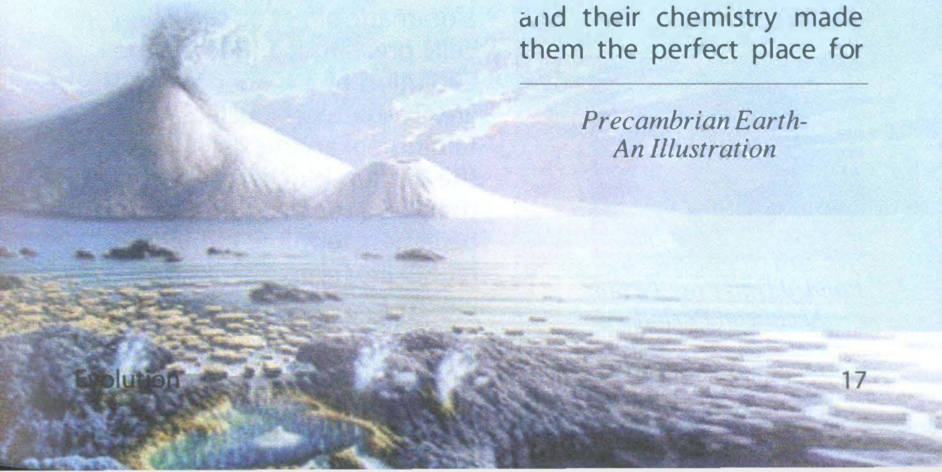
Why is the Precambrian Period extremely significant?


Wow, it's a precambrian stone.

The Precambrian Period spans a long period of the Earth's history. It starts with the planet's creation about 4.5 billion years ago, and ends with the emergence of complex, multicelled life-forms almost four billion years later. It is extremely significant, because it is the earliest of the geologic ages which are marked by different layers of sedimentary rock. Laid down over millions of years, these rock layers contain a permanent record of the Earth's past, including the fossilized remains of plants and animals buried when the sediments were formed.

The Precambrian is divided into two parts- the Archaean time, and the Proterozoic Era. There may not have been many different forms of life, but very important changes were taking place during the Precambrian. The Earth was formed, and its outer covering cooled and hardened into a crust. The hot molten insides of the Earth leaked out at weak places in the crust to form volcanoes. The clouds formed by the volcanoes caused huge amounts of rain to fall, and the oceans were created.

The first life formed. The oceans were like a thick soup, and their chemistry made them the perfect place for



Precambrian Earth- An Illustration

Which Way Up?

Hallucigenia was a bizarre looking fossil which appeared to have tentacles on its back. For a long time, scientists were baffled by it, and unable to determine what kind of creature it was. Finally, they realized that they were looking at it upside

life to begin. The first one-celled organisms formed during the Precambrian Era. They had an important job to do. They helped make the air and water around the Earth full of oxygen. Once there was plenty of oxygen, new life could form. This life would have many cells which would evolve into different kinds of animals. All of the important work of the Precambrian period made the Earth ready for what would come next.

Banded Iron Fossil from Archaean Period

How did oxygen make its appearance in the atmosphere?

In the beginning, the Earth's atmosphere was made up of only nitrogen, carbon dioxide, and some hydrogen. There was very little oxygen present, and it was produced by stromatolites- which are rocks formed by the growth of blue green algae- strewn in the sea. Whatever oxygen was present was quickly absorbed by rocks and minerals. Gradually however, excess oxygen began to accumulate in the atmosphere. This excess oxygen had a dramatic effect on the living cells present. It triggered the evolution of a higher form of life. These were nucleus-containing eukaryotic cells. Thus, the simple blue green algae that were the first form of life, became stepping stones to higher life forms, thanks to rising oxygen levels in the atmosphere.

down! The tentacles were in fact, legs that resembled the tubular legs of today's velvet worms!

Hallucigenia

Spotted Jellyfish

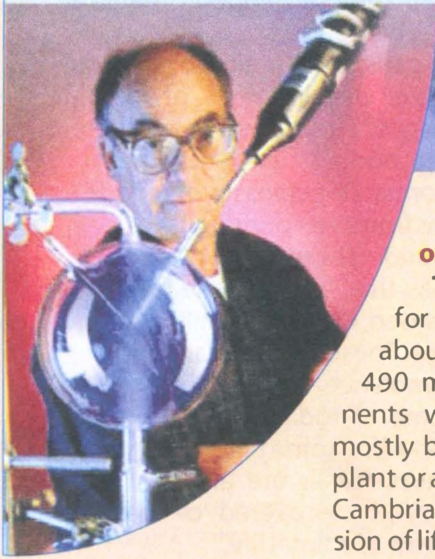
What are metazoans?

Metazoans were the first multi –cellular animals. They could move, respond to their environment, and feed on other organisms. They developed organs, a nervous system, sensory organs, and a brain which led to the development of intelligence. The earliest forms were flat bodied, like today's flatworms. Direct fossils of metazoans from later periods have been found. These are fossils of animals that lived in the sea and the seabed, 680 to 570 million years ago. These fossils bear some resemblance to the bodies of some of today's invertebrates, including some types of jellyfish. These fossils are amongst the earliest discovered of distinct forms of animal life.

Dawn of Life

Stanley Miller, a scientist, devised an experiment to discover the origin of life. He removed all oxygen from his apparatus, which contained the gases that mimic the Earth's atmosphere. He then mimicked lightening flashes by providing an electrical spark. At the end of the experiment, the apparatus contained complex molecules of the kind that are found only in living things.

Stanley Miller



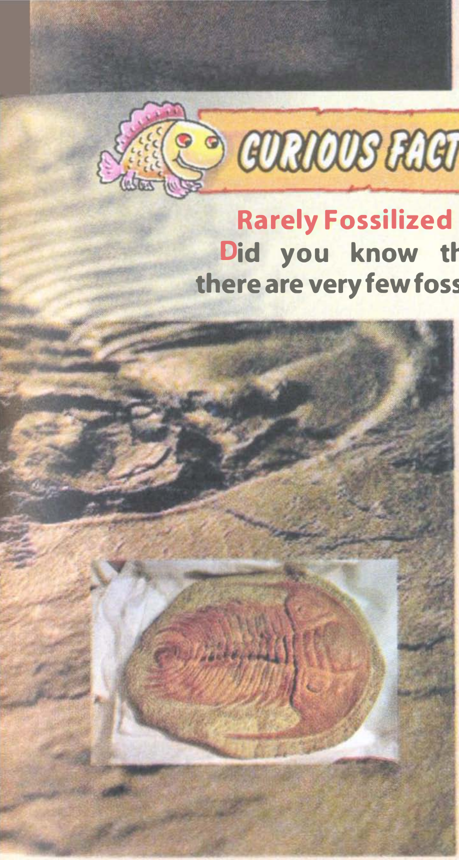
What is the Cambrian period?

The Cambrian Period lasted for nearly 53 million years, from about 543 million years ago, until 490 million years ago. The continents were still forming, but were mostly barren rocks. The land had no plant or animal life on it yet. During the Cambrian Period, there was an explosion of life forms. Most of these were in

CURIOUS FACT

Rarely Fossilized

Did you know that there are very few fossils of lizards, insects and other land animals? Most of the fossils that have been discovered are of animals that lived in the sea.



A Preserved Trilobite

the water. Many animals with no backbones lived in the shallow seas.

The most plentiful species during this period were trilobites. The species got its name from the three lobes in the hard skin. The trilobite was also one of the first animals to have eyesight. There were plenty of other species living during the Cambrian Period also. Molluscs, worms, sponges and echinoderms filled the Cambrian seas. The plants of the Cambrian were mostly simple, one-celled algae.

The Cambrian period ended in a mass extinction. Advancing glaciers would have lowered the temperature of the shallow seas where so many species lived. Changes in the temperature and the amount of oxygen in the water, would have meant the end for any species that could not adapt.

What about my new specs?

Opabinia

STARFACT

Secret Author

Robert Chambers was a well-know literary and intellectual figure who is primarily remembered today as the author of 'Vestiges of Natural History of Creation' in 1844.This work caused a great sensation in Victorian Britain. However, Robert kept the fact that he had written the book a secret.

Why was there an explosion of life during the Cambrian Period?

The Cambrian Period marks an important point in the history of life on Earth. It is the time when most of the major groups of animals first appear in the fossil record. This event is sometimes called the 'Cambrian Explosion', because of the relatively short time over which many life forms appeared. Many reasons have been suggested for this explosion. The first is that the increase in oxygen levels in the atmosphere led to the evolu-

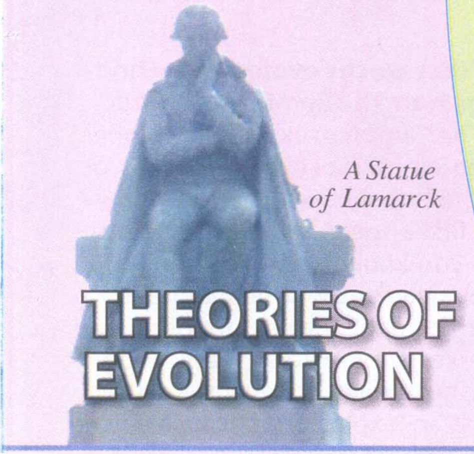
tion of more complex bodystructures. Moreover, many species became extinct at the end of the Vendian Period, and this allowed new life forms to develop. It is also thought that a change in the ocean chemistry made possible the development of hard body parts such as teeth and skeletons. Animals could now swim, burrow, defend themselves, hide, and hunt. However, the sea was still the centre of activity.

What are the evolutionary findings from the Cambrian Period?

The Cambrian explosion is a brief time when most major groups of animals that have bilateral symmetry first appear in the fossil record. Do you know what a bilateral animal is? It is one whose body has two mirror-image halves. Modern examples are lobsters, people, dogs, and butterflies. The event is referred to as an 'explosion,' because a rich diversity of species appeared in a relatively short amount of time. There is growing evidence that these different groups had a common ancestor that lived during the Cambrian Period. Evidence is growing to support this theory, at least from the fossils that date back to this period. After the Cambrian Period, very few additional animal phyla, or large animal categories, arose.

Hand over your money or get ready to become a fossil!
FOSSIL

THEORIES OF EVOLUTION



A Statue of Lamarck

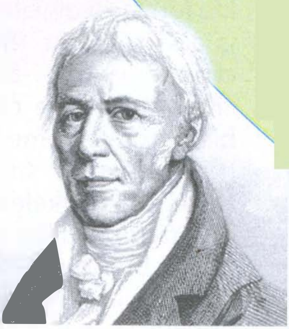
Why is Jean Baptiste de Lamarck a key figure in the history of evolution?

Jean Baptiste Lamarck was a French scientist who developed a theory of evolution at the beginning of the 19th century. His theory involved two ideas. The first was the law of use and disuse, which stated that a characteristic which is used more and more by an organism becomes bigger and stronger, and one that is not used, eventually disappears. The second law was the law of inheritance of acquired characteristics. It stated that any feature of an organism that is improved through use, is passed to its offspring.

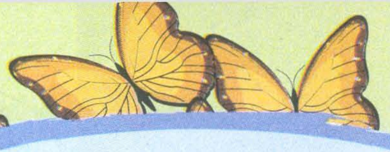
However, Lamarck's theory cannot account for all the observations made about life on Earth. For instance, his theory would predict that all organisms gradually become complex, and simple organisms disappear. But we know that this is not the case, and that simple organisms still exist. So today, Lamarck's theory is largely ignored.

What are subtle fluids?

Jean Baptiste Lamarck believed that all bodies had 'subtle fluids'. These were weightless fluids pervading all space and bodies. Two good examples of eighteenth-century subtle fluids were electricity and heat. Lamarck believed that subtle fluids were responsible for both movement and change. For example, Lamarck pointed out that snails have poor vision because the feelers on their heads acted as their eyes.

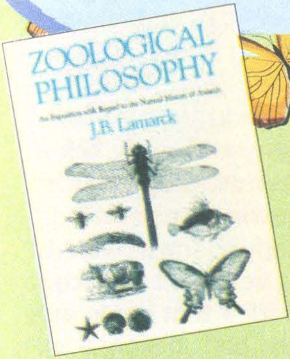


Jean Baptiste Lamarck



Butterfly Evidence

Lamarck supported his theory of evolution with the example of butterflies. According to him, you find different species of butterflies in different places because butterflies in one place acquire certain characteristics to survive in their environment, and pass on these characteristics to the next generation.



Lamarck's book Zoological Philosophy

Lamarck handing over his book to Napoleon

According to him, the ancestors of snails did not have feelers. They groped about with their heads to find their way around. This groping sent subtle fluids to the front of the head, and the constant presences of moving subtle fluids eventually brought about the development of feelers, and these feelers were passed from generation to generation.

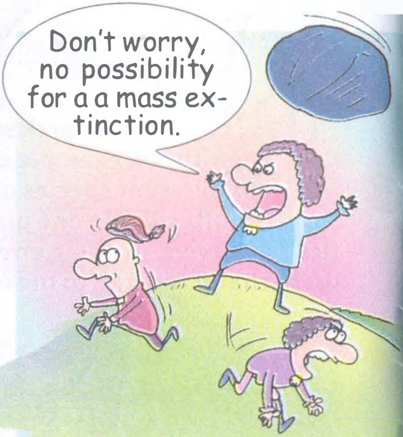
This is a subtle fluid
I can't see anything!

Platypus

CURIOUS FACT

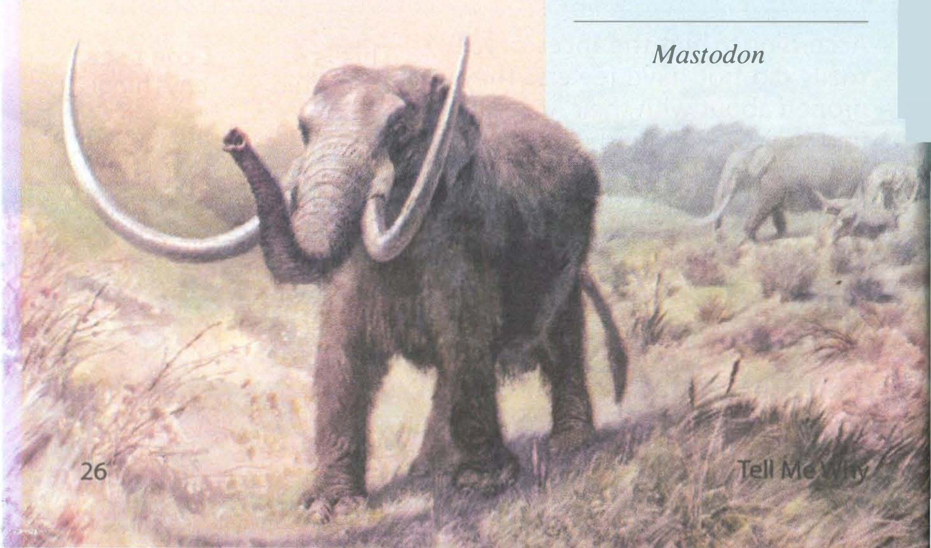
Lost Worlds

The duck billed platypus of Australia is a strange looking bird that was discovered only in 1799. This made several people believe that there might be many other weird animals alive in some remote corner of our planet and that animals that were thought to be extinct might still exist in some unknown place.


Don't worry, no possibility for a a mass extinction.

Why did early scientists not accept the idea of extinct animals?

Early scientists were, at first, reluctant to accept the idea that some animals had become extinct. According to the Bible, even when a great



Mastodon

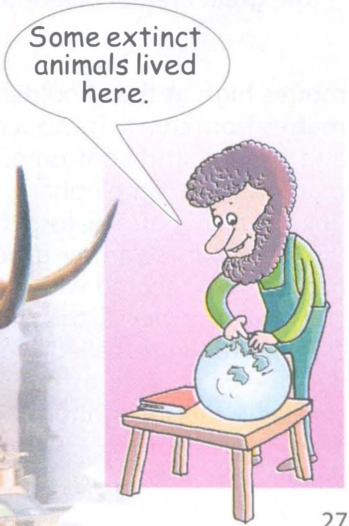
flood covered the Earth, Noah had managed to save a male and female of all species to ensure that no animal would become extinct. When the first fossils of unknown animals were discovered, it was believed that these animals still existed in some unexplored region of the Earth. However, the discovery of fossils of giant animals like the mastodon shook this belief, as it was unlikely that there were unexplored regions large enough to hide such animals. French scientists were the first to accept that these giant animals might have roamed the Earth thousands of years ago, and become extinct due to a variety of causes. Slowly, this idea came to be accepted worldwide.

Mounted Mastodon Skeleton

Why is Charles Willson Peale an important figure in the history of evolution?

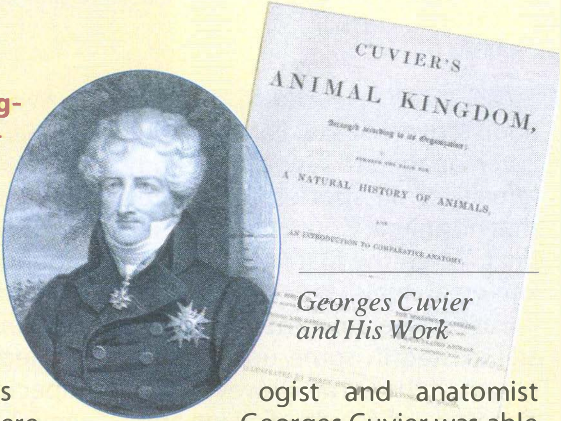
Charles Willson Peale founded a museum in Philadelphia, Pennsylvania, in 1786. It contained a collection of natural history specimens, portraits of admirable historical figures, and human artefacts from various countries. His purpose was to show the place of human beings as part of the animal kingdom.

His most famous display, however, was the mastodon skeleton he obtained in 1801. Measuring 3.35


Some extinct animals lived here.

Why are Georges Cuvier's theories important?

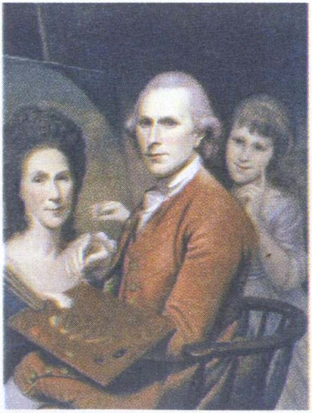
For many years, scientists refused to accept that some animals had become extinct. When remains were found that were unlike anything living at the time, they argued that they were unusual examples of living creatures, or that animals known only from fossils must still survive in some unexplored part of the world. It was only at the end of the 18th century that the great French paleontologist and anatomist Georges Cuvier was able to demonstrate convincingly that extinctions were real.


CUVIER'S
ANIMAL KINGDOM,
A NATURAL HISTORY OF ANIMALS,
AN INTRODUCTION TO COMPARATIVE ANATOMY.

Georges Cuvier and His Work

Cuvier was convinced that plants and animals of all types were created for their particular roles and places in the world's environment, and that they were unchanging throughout their existence. According to him, catastrophic events in the

metres high at the shoulder, and 4.5 metres from chin to rump, it was huge and strange and confusing. Was it a man or beast, an elephant, or some unknown animal? The fossil had been discovered in swampy ground, and had been excavated with great difficulty. Man or beast, this 'monstrous creature', as it was called, would soon become celebrated as the unknown species or the 'incognitum'.



Charles Willson Peale

course of history had killed off all members of some species, and their fossils would no longer be seen in the rocks. Subsequently, he believed, the old species were replaced by new ones that repopulated Earth.

Cuvier had an almost uncanny ability to reconstruct animals from only fragments of fossil remains. With elegant studies of the anatomy of large mammals such as elephants, Cuvier showed that fossil mammoths differed from any such creatures presently living. His many examples of fossils telling the stories of animals that lived and then disappeared, were taken as incontrovertible proof of extinctions.

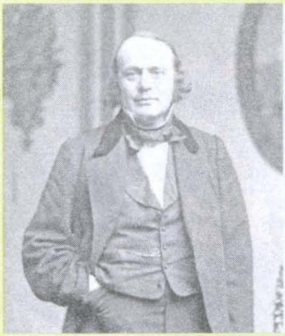
Evidence From Egypt

Napoleon Bonaparte invaded Egypt in 1798. When he returned to France, he brought back many mummies, including that of a mummified ibis. Its skeleton was the same as of that of a living ibis, and this was cited as evidence that evolution did not occur, as Lamarck had claimed.

Napoleon Bonaparte

Mummified Ibis

Hugh Miller



Louis Agassiz

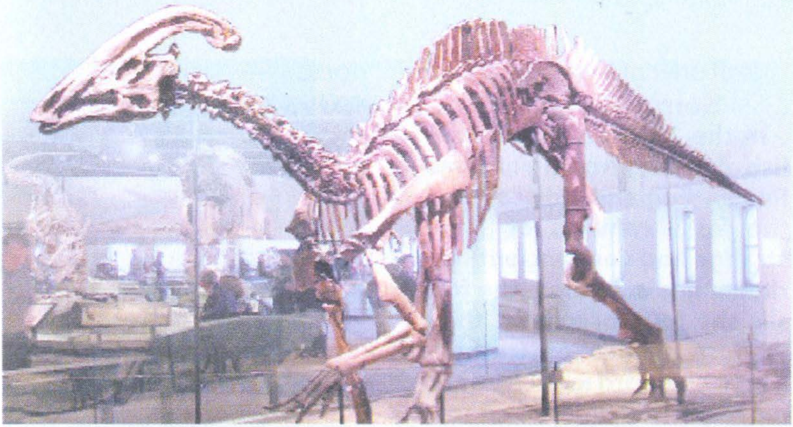
Why are Hugh Miller and Louis Agassiz famous?

Hugh Miller was a 19th century geologist. He put forward the theory that there had been several successive creations, and that each had been destroyed by a catastrophe. According to him, the Bible dealt with only the last creation. Miller explained the presence of fossils as being the remains of animals from an earlier creation.

Louis Agassiz was a Professor of Zoology and Geology. He did landmark work on glacier activity and extinct fishes. He encouraged learning through direct observation of nature. Agassiz put forward the theory of a new catastrophe-the Ice Age. He believed that a sudden intense Ice Age gripped the Earth for ages, and wiped out all the existing animals and plants. His concept of the Great Ice Age brought him much fame, as he was able to present evidence in the field, especially the scratched surfaces of bedrock where rocks in the moving ice had gouged out deep marks.

Darwin's Enemy

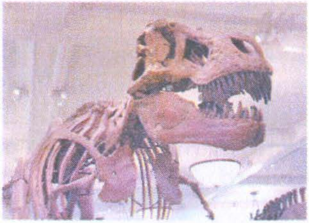
Richard Owen was the man who gave dinosaurs their name. He was an outstanding naturalist with a special gift for interpreting fossils. He disagreed with Darwin's Theory of Evolution, and wrote reviews about the book that Darwin wrote on the subject.



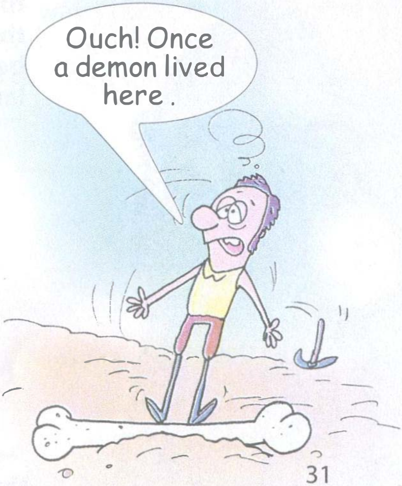
When was the first dinosaur fossil discovered?

Dinosaur fossils were probably discovered by the ancient Chinese, Romans, and Greeks. However, no one really recognized them as belonging to an extinct animal. Much later in 1676, a huge thigh bone was found in England by Reverend Plot. It was thought that the bone belonged to a 'giant', but was probably from a dinosaur.

The first dinosaur to be described scientifically was Megalosaurus, named in 1824, by William Buckland. The name 'dinosaur' which means 'terrible lizard,' was actually coined by Richard Owen. In 1838, William Parker Foulke found the first nearly complete dinosaur fossil remains in New Jersey, USA. Since Buckland's original discovery in 1819, approximately 330 different dinosaur genera have been discovered thus far.

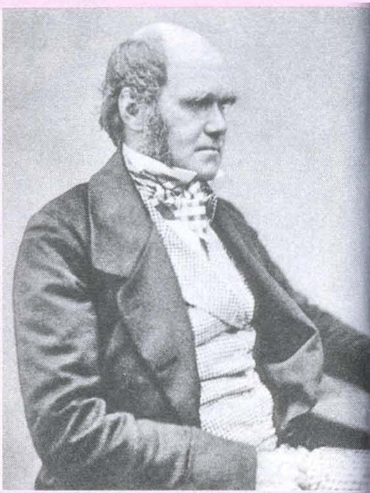


Skeletons of Dinosaur


Ouch! Once a demon lived here .

Surprising Finds

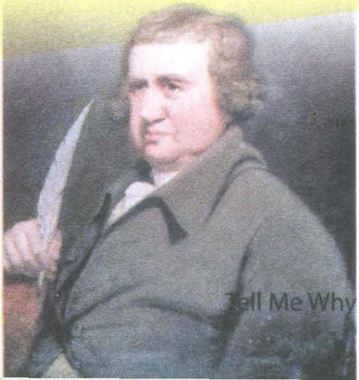
In the 1800's a young English girl, Mary Anning of Lyme Regis, England, discovered the fossil remains of some strange and very ancient marine animals. In time, the fossils she found received their modern names of ichthyosaurs. The word ichthyosaurs, means 'fish lizards', and fossils of these creatures prove that they were dinosaurs that lived in the sea. The first scientist to describe ichthyosaurs was Dr. William Buckland, professor of geology at Oxford.

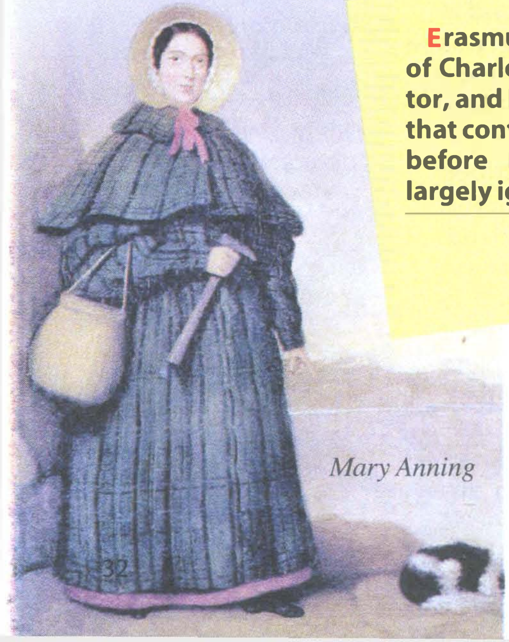

Charles Darwin

Erasmus Darwin

Erasmus Darwin was the grandfather of Charles Darwin. He was a poet, doctor, and botanist. He had written books that contained evolutionary ideas even before Lamarck, but his work was largely ignored.

Erasmus Darwin




Mary Anning

Why is the word 'evolution' associated with Charles Darwin?

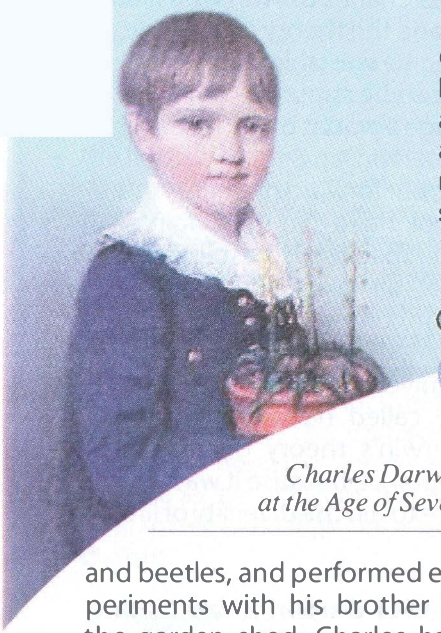
When you think of evolution, the first name that comes to one's mind is that of Charles Darwin. However, the fact is that he was not the first person to put forward the idea of evolution. Lamarck had suggested it earlier, but the concept was not popular. In fact, a zoology professor, Robert Grant, lost his job because he supported Lamarck's theory! An anonymous work titled 'The Vestiges of Creation,' was ridiculed. It was Charles Darwin who first made the theory acceptable, and he was able to do so because he supported it with a huge amount of evidence.

Darwin, an English naturalist, put forward his theory in a book titled 'On the Origin of the Species'. He established that all species descended from common ancestors, and that the different species evolved through a process he called natural selection. Darwin's theory gained acceptance because it was able to explain the diversity of life.

HMS Beagle

Why is Charles Darwin a fascinating figure?

Charles Darwin was a brilliant naturalist who changed the way people think about life on Earth. From a young age, Darwin collected lots of different things like stones



Charles Darwin at the Age of Seven

STARFACT

Beetle Mania

Did you know that as a child, Charles Darwin was fascinated by beetles? He loved collecting them, and in fact had a huge collection. As a student, Darwin got into a heated rivalry with another Cambridge student, Charles 'Beetles' Babington, over who would acquire a new species first!

and beetles, and performed experiments with his brother in the garden shed. Charles had an amazing life. He travelled the world, saw volcanoes explode, and earthquakes rode on the back of giant tortoises, and went hunting for ostriches.

When Charles was 22, he was invited to join a voyage round the world on a ship named 'Beagle'. When the Beagle stopped at the Galapagos Islands, in the Pacific Ocean, Darwin found some really strange animals. He collected lots of specimens while he was away, and when he returned home he started thinking about how animals and plants change through time. He concluded that different individuals might survive better than others because they are a little bit bigger or better at something, and he called this 'natural selection by survival of the fittest'. He also concluded that animals that do survive often have more offspring, and these young ones inherit their parents' strengths. In 1859, he finally wrote a book about what he had found out. It was called 'On the Origin of Species'. It was a sensation! Charles' ideas meant that humans weren't special- they had evolved too, just like any other animal. Darwin had so much evidence that scientists decided he was right.

Why was Darwin's journey very interesting?

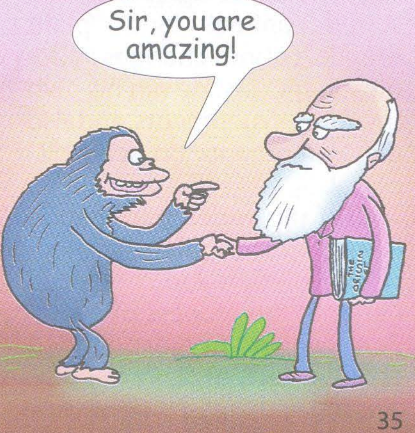
Darwin's voyage on the ship 'Beagle,' was a key turning point in his life. His role was to be a private naturalist. With its eager passenger aboard, the Beagle left England on December 27th, 1831. The ship reached the Canary Islands in early January, and continued onward to South America, which they reached by the end of February 1832.

During the explorations of South America, Darwin was able to spend considerable time on land, sometimes arranging for the ship to drop him off, and pick him up at the end of an overland trip. He kept notebooks to record his observations.The Beagle reached the Galapagos Islands in September 1835. Darwin was fascinated by such oddities as volcanic rocks and giant tortoises.

In January 1836, the Beagle arrived in Australia, and then reached the Cape of Good Hope. The Beagle sailed back to the coast of South America before returning to England, arriving at Falmouth on October 2nd, 1836.

In the following few years, Darwin wrote extensively about his experiences.His experiences on this journey led to the publication of 'On the Origin of Species,' in 1859.

Young Charles Darwin



What were the two tasks set by Darwin?

Darwin had two goals in mind. First, he wanted to work out the mechanism by which evolution occurs. Secondly, he wanted to collect enough evidence to convince people of his theory of evolution. He sought information from his many contacts to help him refine his theory. In 1837 Darwin began his first notebook on evolution.

For several years, Darwin filled his notebooks with facts that could be used to support the theory of evolution. He found evidence from his study of the fossil record. He observed that fossils of similar relative ages are more closely related than those of widely different relative ages. He consulted animal and plant breeders about changes in domestic species. He ran his own breeding experiments, and also did experiments on seed dispersal.

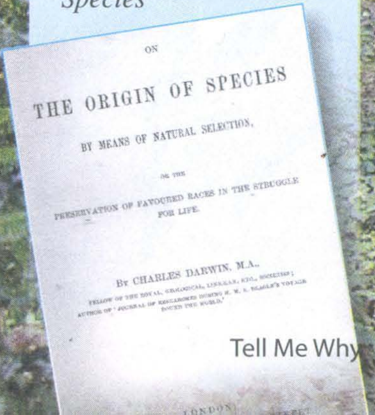
All of this varied information helped him formulate his theory of evolution and convinced him that the process of evolution which he expounded could in fact, explain the patterns he saw in the natural world. Darwin's theory introduced the concept that organisms are modified over vast periods of time by naturally occurring processes, originating from common ancestors that lived tens of millions of years ago.

STARFACT

All about Worms

Darwin was fascinated, not just by beetles, but by worms too. After publishing 'On the Origin of Species' he studied earthworms, and even published a book about them.

On The Origin of Species



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE
FOR LIFE.

By CHARLES DARWIN, M.A.,

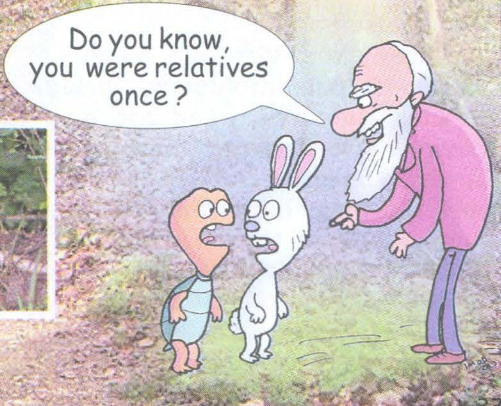
Armed Ancestor

Darwin was delighted by the armadillos he saw scurrying about in Argentina. But most intriguing was the striking similarity of these small, armoured mammals to some of the fossils he was unearthing. One such fossil was glyptodon, an immense shelled animal that looked like a giant armadillo. In fact, to Darwin, many ancient, extinct species seemed to be giant versions of living species.

Armadillo

What are some evidences of Darwin's theory?

Most of the evidence for evolution comes from fossil records. Many living animals also support Darwin's theory. For example, all Mediterranean bee orchids may look like. But they cannot interbreed, proving that they belong to different species, but have a common ancestor. There is a strong resemblance between a bat's wing and a dolphin's flipper, suggesting a common ancestor once again. The arms and hands of chimpanzees are very similar to other vertebrates. The armadillo's forelimb is short and sturdy to give it the power for digging, while horses' legs have become adapted for running.


Do you know, you were relatives once ?

How did Darwin explain the distribution of plants and animals?

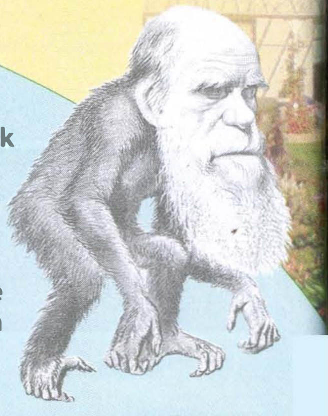
Before Darwin's Theory of Evolution was accepted, people believed that God created each species to suit the specifications of the area it lived in. However, the puzzling distribution of plants and animals in South America and the Galápagos made Darwin question how species originated. If each plant and animal was created to match its habitat, why didn't the same species appear in similar environments?

As Darwin would later come to realize, if the two species had arisen from a single common ancestor, it would make sense for them to live close together. The pattern of geographic separation he observed was exactly what one would predict if new species evolved from existing ones. Darwin was able to show that migration and evolution are the most logical explanations for the patterns of distribution of plants and animals that are seen on the planet.

STARFACT

False Fossils

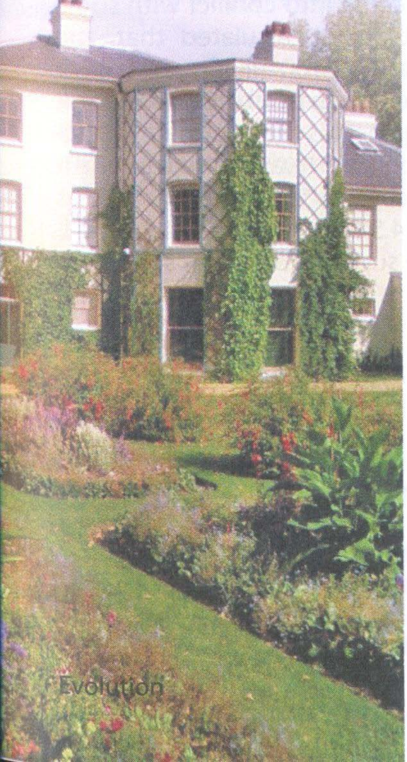
To many mid-Victorian geologists and paleontologists, including Darwin, laminated green and grey rock specimens from altered limestones of the Canadian Shield of Ontario and Quebec were the most important fossils ever found, because they constituted evidence of the existence of complex life forms. They were called 'Eozoon' or dawn animals. However, it was later shown that they were not fossils at all, but crystals.



Age of the Weald

Darwin lived in an area in Southern England called the Weald. He tried to estimate the age of the Earth by studying the geological structure of the area. However, his calculations were wildly off the mark.

Mesosaurus

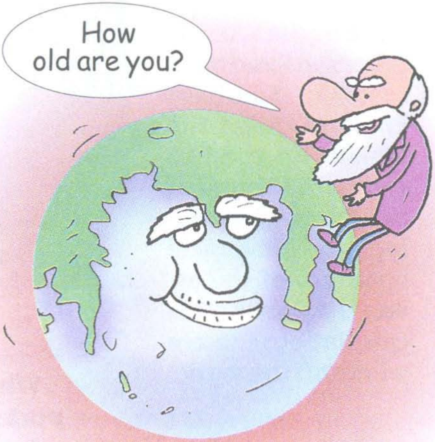


Charles Darwin's Home

Why was fossil evidence important to Darwin?

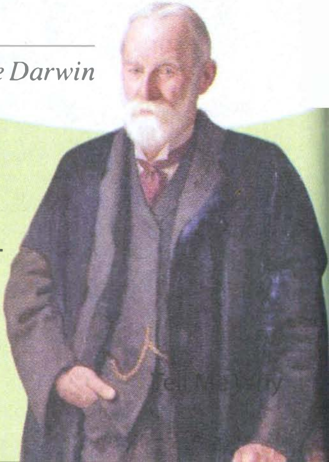
Scientists at the beginning of the 1800's knew about some kinds of fossils. Charles Darwin studied fossils carefully to prove his theory of evolution. He found no strong evidence against evolution, and much in its favour. When fossils are arranged in the order of their age, a continual series of change is seen, new changes being added at each stage. The fossil remains of the now-extinct reptile Mesosaurus found in Africa and South America provided one of the earliest clues to a former connection between the two continents. Mesosaurus was a freshwater species, and so, clearly incapable of a trans-atlantic swim. Therefore, it must have lived in the lakes and rivers of a landmass that later became divided as Africa and South America, and drifted apart.

Why was Darwin concerned about the age of the Earth?


How old are you?

Charles Darwin is most famous for his work on natural selection, the idea that all species of life have evolved over time from common ancestors. This process involves favourable traits becoming more common in successive generations of living things, while at the same time, unfavorable traits become less common.

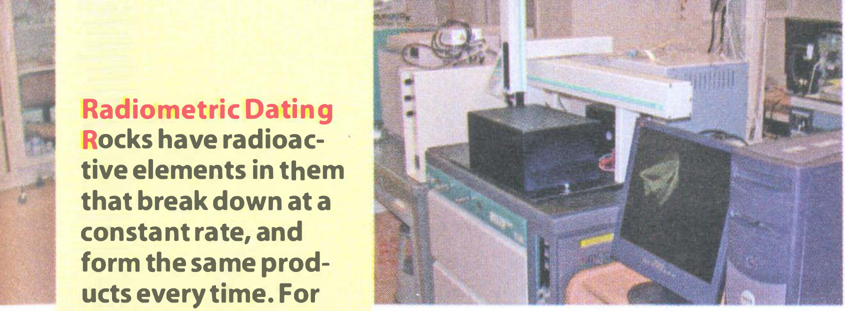
For Darwin's theory to be correct, it was essential that the Earth be hundreds of millions of years in age, because the process of natural selection is a long one needing enormous amounts of time. Darwin came into conflict with some scientists who calculated that, the Earth was only 100 million years old or less. Their claim troubled Darwin, as it went against his theory. However, later the confusion was cleared up, and it was accepted that the Earth was around 4.5 billion years old. This calculation supported Darwin's theory.



George Darwin

Astronomer Son

Charles Darwin had 10 children. One of them, George Darwin was a mathematician and astronomer. He was among the first to realize that radioactivity was constantly warming the Earth's crust and calculations of the Earth's age based on heat loss were meaningless.



Mass Spectrometer- An Instrument used in Radiometry

Radiometric Dating

Rocks have radioactive elements in them that break down at a constant rate, and form the same products every time. For example, potassium 40 found in volcanic rocks breaks down to give argon 40. So, the more argon 40 there is in a rock, the older it is. This method of dating rocks is known as radiometric dating.

Why was Darwin interested in artificial selection?

Darwin was interested in artificial selection. During his lifetime, new varieties of plants and new breeds of animals were bred through artificial selection. This involves breeding only those individuals that have desired qualities, and rejecting the rest. For example, animal breeders are often able to change the characteristics of domestic animals by selecting for reproduction those individuals with the most desirable qualities such as speed in racehorses, milk production in cows, trail scenting in dogs.

Over the years, those plants with desirable characteristics are grown by Man. Meanwhile, plants without these characteristics are less likely to survive. Eventually, the species of the plant will evolve. This supported Darwin's theory that the strengths acquired by natural selection are indeed passed on to subsequent generations resulting in evolution.

A Great Dane

STARFACT

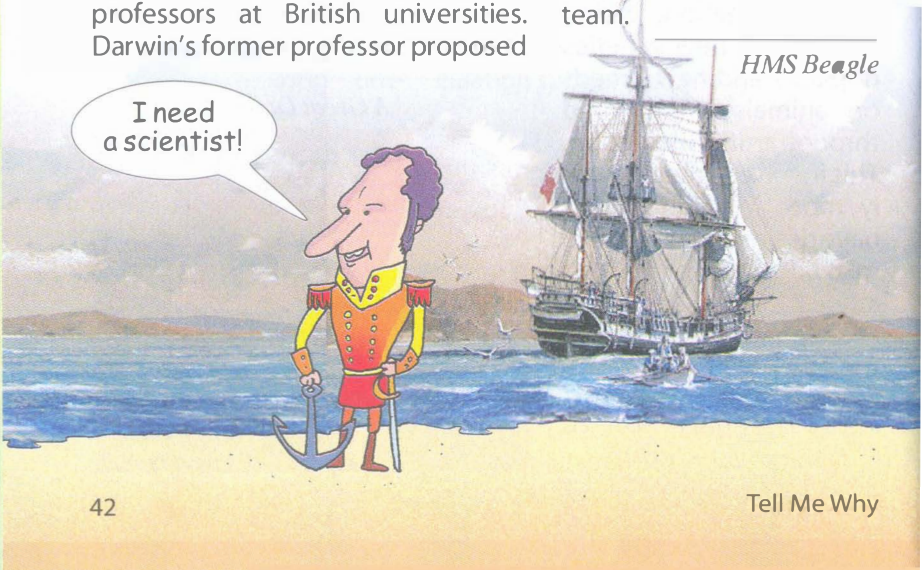
Bald Dog

The Chinese crested dog is an example of how breeders can alter the temperament, shape, size, and colour of an animal. This dog is bald, and has only wisps of hair on its head and tail, but breeders can make its coat long or short, straight, or curly.

How did Darwin become a part of the Beagle's expedition?

The HMS Beagle went on a lengthy scientific mission several years before Darwin came into the picture. On its second voyage, Captain FitzRoy was to command the ship. FitzRoy wanted to take along someone with a scientific background who could explore and record observations. Inquiries were made among professors at British universities. Darwin's former professor proposed him for the position aboard the Beagle.

Darwin was very excited at the idea but his father was against it. Other relatives convinced Darwin's father to let him go, and during the fall of 1831, the 22-year-old Darwin made preparations to depart England to join the Beagle team.



HMS Beagle

I need a scientist!

The Viana Desert on the Island of Boa Vista

Don't be confused. This is a travelling sea shell!

Which was Darwin's first interesting discovery?

The H.M.S. Beagle arrived at the Cape Verde Islands on 16th January 1832, and anchored at Porto Praya, on the island of Santiago. It was here that Darwin discovered horizontal bands of white shells within a cliff face along the shoreline. This layer was more than thirteen and a half metres above sea level, and Darwin wondered how shells that are usually found under the ocean could be present so high up on land. Since the layer was intact, any upward movement of the land would have to be very gentle, for violent movement would have broken up the layer. This discovery set Darwin thinking, and his thoughts would eventually lead to his theory about how ocean floors sank, and continents rose up.

Fossils in Patagonia

Darwin spent many weeks collecting fossils in Patagonia. He found huge fossils on a cliff, and these later turned out to be the remains of giant rodent like animals, most of which were completely unknown at that time.

Why was Darwin's visit to Rio de Janeiro important?

On April 4th, 1832, the Beagle arrived in Rio de Janeiro. For ten weeks, while FitzRoy on the Beagle upgraded British charts of the Brazilian coast, Darwin lived in a cottage on Botafogo Bay at Rio de Janeiro. While in that cottage, Darwin studied mud-dauber wasps which made clay, and then stuffed them 'full of half-dead spiders and caterpillars'. He also saw a fight between a wasp and a spider that helped him understand 'the struggle for survival'.

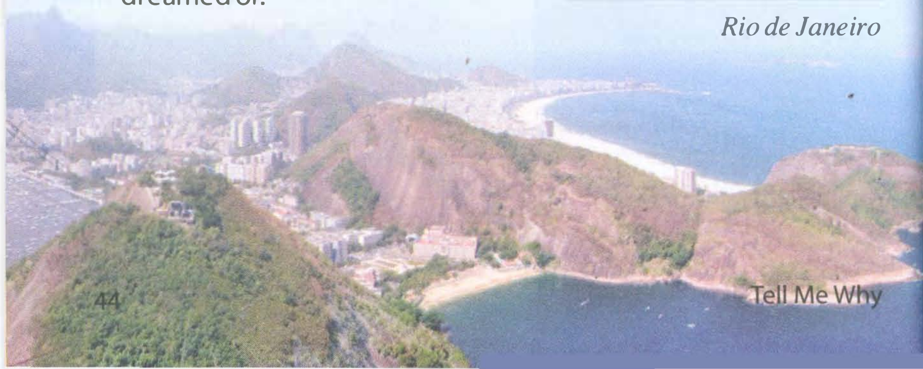
Darwin wrote about the frogs, and 'a pleasing chirp' of crickets he heard there at night. He also roamed all around the nearby countryside. Darwin collected many specimens of plants and insects during a trek up the coast- and his collection exceeded anything he ever dreamed of.

Cavia

STARFACT

Darwin's Second Collection

Darwin's second collection of specimens consisted of the teeth of a giant rodent like animal called Cavia, the upper jaw and head of a large animal, the lower jaw of another one, marine shells, snakes, lizards, a toad, crustaceans, dried plants, seeds...and of course, his favourite beetles!



Rio de Janeiro

Hermit Island

On 24th December, H.M.S. Beagle was off Cape Spencer at Hermit Island. Later in the day, it moved to St. Francis Bay to hunt game for the next day's Christmas feast.

Why did Darwin's team stay in the Beagle Channel?

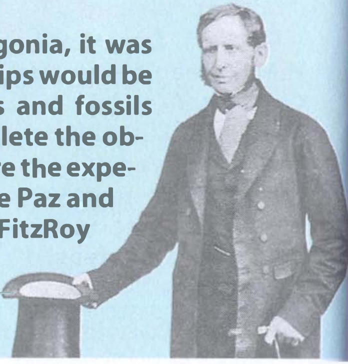
One of the objectives of the Beagle's Captain, FitzRoy, was to return three natives whom he brought from Tierra del Fuego, to their homeland. These natives were known as Fuegians. Rev. Richard Matthews of the Anglican Church Mission Society, who hoped to establish a mission in the Fuegians' land, would be accompanying them.

On January 18th, FitzRoy took the three Fuegians, twenty members of his crew and Darwin in four boats down the Beagle Channel. This channel is a strait separating Tierra del Fuego from the extreme tip of South America, and it was named after the ship in one of its previous voyages. On January 23rd, the four boats arrived at the Fuegians' village where the mission was to be started. The next few days were engaged in setting up the mission, and the Reverend Mathews and the three Fuegians who had been trained under him, were left to run the mission. For Charles Darwin, the trip down Beagle Channel was unforgettable, as it gave him his first glimpse of glaciers.

Aerial view of Beagle Channel

Two More Schooners

By the time the Beagle reached Patagonia, it was obvious to Captain FitzRoy that more ships would be needed to transport all the specimens and fossils that Darwin had collected, and to complete the objectives that the Admiralty had set before the expedition. So, two additional schooners, the Paz and the Liebre were hired to assist Captain FitzRoy and the Beagle.

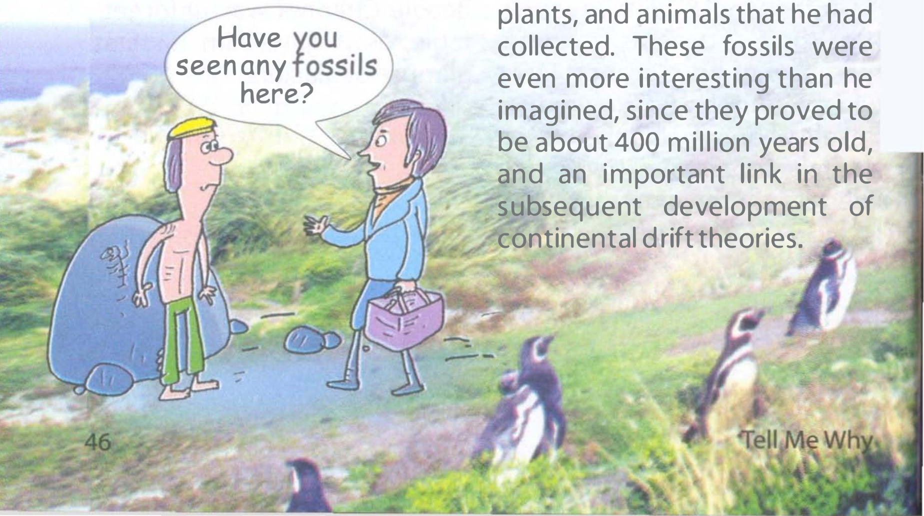


Captain FitzRoy

What was significant about Darwin's stay in the Falkland Islands?

On March 1st 1833, HMS Beagle dropped anchor in Berkeley Sound, and Darwin had his first glimpse of the Falkland Islands. His first recorded impression of the Falklands was accurate enough '... the land is low and undulating with stony peaks and bare ridges; it is universally covered by a brown wiry grass, which grows on the peat', he wrote.

Darwin spent the next few weeks collecting fossils. He found that these fossils were very different from those that he had found in South America. This inspired him to do a comparative study of all the fossils, plants, and animals that he had collected. These fossils were even more interesting than he imagined, since they proved to be about 400 million years old, and an important link in the subsequent development of continental drift theories.


Have you seen any fossils here?

Mount Darwin

In 1834, Charles Darwin was on a voyage of discovery. Darwin spent months in the region of Tierra del Fuego, the southern archipelago at the tip of South America. February 12th, 1834 was Charles Darwin's 25th birthday. So, the Captain of the Beagle, FitzRoy, named the tallest peak in Tierra del Fuego, Mount Darwin, in his honour.

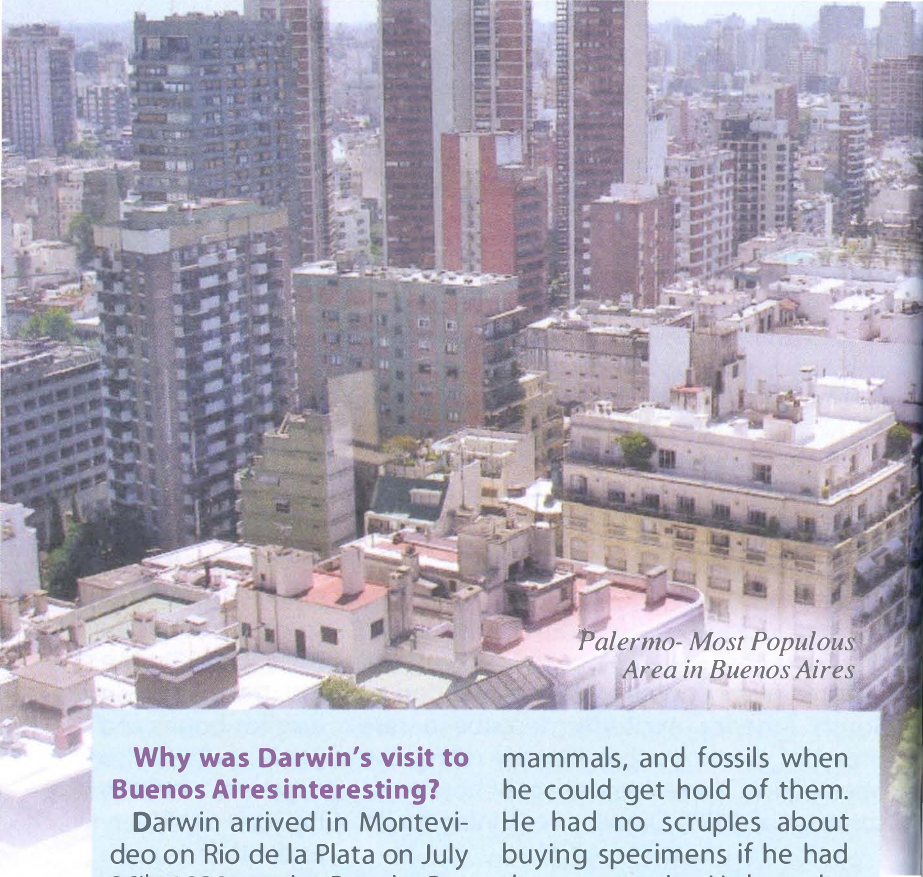
A Gaucho

What were Darwin's experiences with the Gauchos?

Notes from Darwin's 1833 expedition to South America excitedly describe a rare breed of cowboys that he saw riding the open plains. These were the gauchos. In the summer of 1833, Darwin went inland with some gauchos in Argentina. During his treks, Darwin dug for bones and fossils, and was also exposed to the horrors of slavery and other human rights abuses.

The gauchos also had a lot of fun at Darwin's expense, when they tried to teach him how to catch game like they did. At the end of his time with them, Darwin had increased his specimen collection.

Help me!
He is the best rider here!



Palermo- Most Populous Area in Buenos Aires

Why was Darwin's visit to Buenos Aires interesting?

Darwin arrived in Montevideo on Rio de la Plata on July 26th, 1832 on the Beagle. But he saw Buenos Aires only on September 20th when he arrived there, having travelled on horse-back from Bahia Blanca in the South. He collected natural history specimens from the area widely and carefully. From South America, he collected complete suites of insects, small invertebrates, birds, spiders, corals, molluscs, mammals, and fossils when he could get hold of them. He had no scruples about buying specimens if he had the opportunity. He knew he would never be able to visit again, and that he should not miss any chance to gather as much information as possible. He collected fossils of huge animals and wondered how these animals could survive on the sparse vegetation present. He was also puzzled as to how they had become extinct.

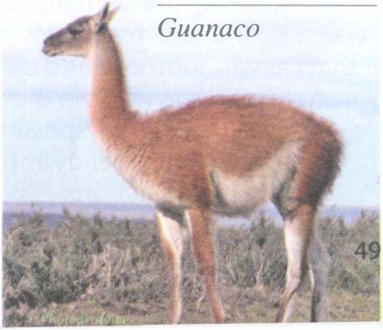
What was Darwin's discovery at Punta Alta?

Darwin's search for fossils led to a very interesting find at Punta Alta. He found the fossil of a very large animal that was embedded in a cliff face below a layer of white sea shells. This layer was very similar to a layer he had discovered a year earlier in Santiago. This discovery puzzled him immensely, and set him wondering what the creature was, why it had become extinct, and why it was not found anywhere else in South America. Darwin harvested from Punta Alta the remains of nine great mammals, all unknown, or barely known to science. They were later proved to be extinct Pleistocene giants, unique to the Americas, in an age sometime before 12,000 years ago.

What were the interesting findings of Darwin on his journey south?

After leaving Montevideo, the Beagle, accompanied by the schooner Adventure sailed south. As the ships entered San Blas Bay, they were enveloped by a cloud of butterflies. This phenomenon puzzled Darwin, as there were no air currents at that time that could have swept the butterflies out to sea. Later, the ships reached Port Desire, and Darwin went on shore to examine the landscape. He also used the time to write at length in his journal about the limited flora and fauna, especially the guanaco, a llama-like animal.

Another feature that fascinated him was the river valley in the region. After careful study, Darwin concluded that the river valley cliffs had once been under the sea, and had been slowly pushed upwards.



Guanaco

Giant Dog

All breeds of dogs are descended from the European wolf. However, they vary in size from the one metre tall Irish wolfhound, to the tiny Chihuahuawhichisonly 20 cms in height.

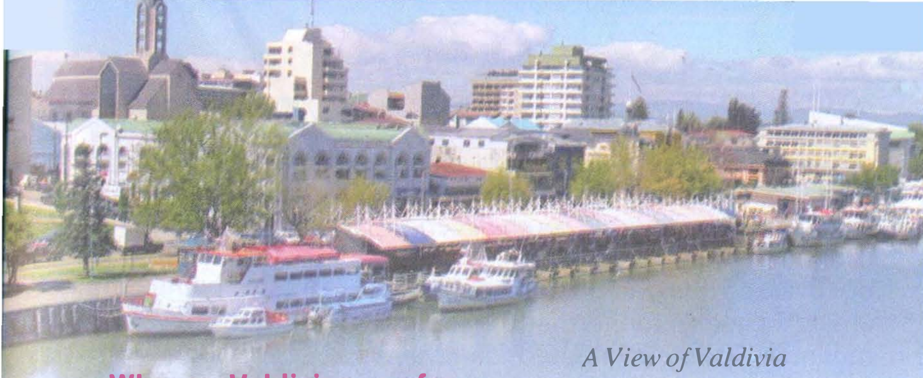
Irish Wolf Hound

Chihuahua

Why did Darwin dislike Chiloe Island?

The Island of Chiloe is an island near the coast of Chile. The island was covered with evergreen forests and inhabited by native Indians who were very poor. Darwin found the place depressing because it was raining constantly! The Beagle next sailed to the city of Valparaiso in Chile. Here, the climate was much warmer, and the town was so pretty that Darwin soon cheered up. He went on several long walks in the countryside, collecting specimens to add to his already impressive collection.

Here, I can see only rain...
Darwin
CHILOE ISLAND



A View of Valdivia

Why was Valdivia an unforgettable experience for Darwin?

On February 20th, 1835, a massive earthquake hit Valdivia, and Darwin was right in the middle of the action. In his own words, "This day has been remarkable in the annals of Valdivia for the most severe earthquake which the oldest inhabitants remember". He described the earthquake graphically with the words "An earthquake like this at once destroys the oldest associations; the world, the very emblem of all that is solid, moves beneath our feet like a crust over fluid". The devastation was horrible - nearly every building in the area was destroyed. On his arrival at the island of Quiriquina, when he explored around the island, he found areas of land that had risen a few feet due to the earthquake. Darwin became very excited because this was direct evidence that the Andes Mountains, and indeed all of South America, were very slowly rising above the ocean.

Copper Butterfly

STARFACT

Changing Butterfly

Copper butterflies vary greatly in size and colour. Did you know that in a cool summer, darker butterflies have an advantage as they warm up more quickly than light coloured ones?

Why was Darwin amazed when he explored the geology of Villavicencio?

Charles Darwin visited Villavicencio in Argentina during his South American journeys in the 19th century, and discovered a geological sequence that amazed him. He found that the local mountains were composed of lava flows that are usually found under the sea. These lava flows were now found at a height of 1828 metres - and that too, 1126 kilometres from the coast.

He was also wonderstruck by the fossilized coniferous trees that he found there, along with huge numbers of petrified trees, which are trees that have turned into stone over the ages. It was obvious that this land had once been under the ocean, but Darwin wondered how the trees that had become petrified had ended up under water. These discoveries led Darwin to develop geological theories of his own.

STARFACT

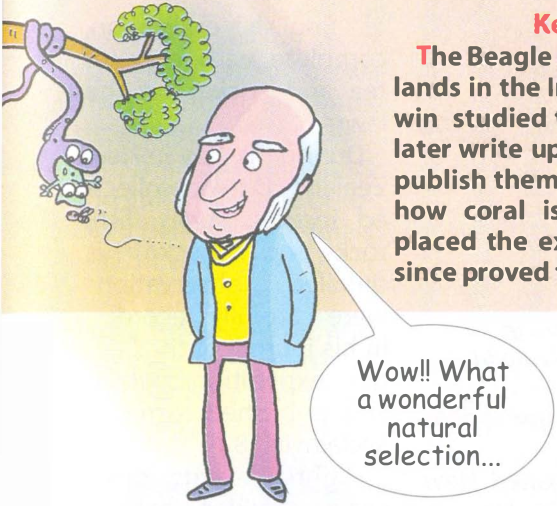
Darwin the Explorer

In the Galapagos, Darwin found a remarkable population of plants, birds and reptiles that had developed in isolation from the mainland, but often differed on almost identical islands next door to one another. Darwin rode tortoises, watched lizards, tossed iguanas into water, and collected his specimens all in the cause of science. He could explain the characteristics of the unique animals he found with his theory about a gradual transformation of the various species.

Villavicencio

Keeling Islands

The Beagle stopped at the Keeling Islands in the Indian Ocean, where Darwin studied the coral reefs. He would later write up his notes on corals, and publish them as a book. His theory on how coral islands were formed replaced the existing theories, and has since proved to be wholly correct.


Wow!! What a wonderful natural selection...

Why was Darwin excited about reaching Galapagos?

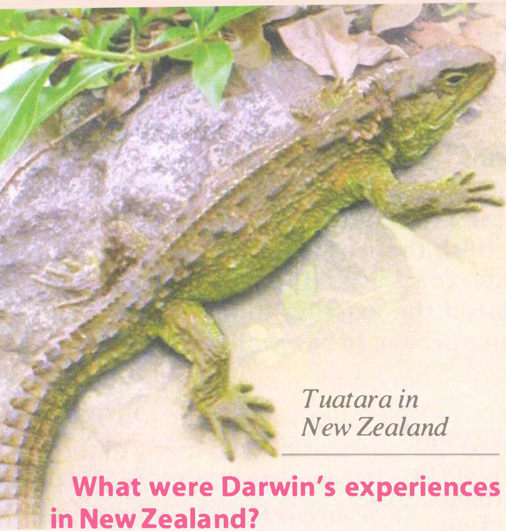
Charles Darwin's visit to Galapagos resulted in much attention being paid to these islands, and consequently, many fascinating things have been discovered about them. One of the main questions that excited him was how so many different plants and animals arrived on the islands in the first place.

The periodically changing currents may have allowed many different species to immigrate to the islands. Also, during the rainy season, rafts of vegetation break off and float out to sea. Most of the reptiles, the only terrestrial mammals and insects must have arrived by this route. The light spores of many lower plants could have been blown in by the wind along with lighter seeds.

Once on the islands, the various species established themselves, and determined territories. Evolution then set in, and many unique species, such as the finches that fascinated Darwin, were the result.

Galapagos Iguana

Galapagos Land Iguana



Tuatara in New Zealand

What were Darwin's experiences in New Zealand?

Charles Darwin's ship visited New Zealand in December 1835. He was not particularly impressed with the countryside, and was quite appalled by the natives, because he felt that they had many vices, and practiced cannibalism. After a few uncomfortable days visiting the local settlements, Darwin and the captain of his ship, FitzRoy were invited by CMS missionary William Williams to visit the Waimate mission. At Waimate, FitzRoy and Darwin were pleased to find an oasis of English civilization, complete with cups of tea and cricket on the lawn!

During his stay in New Zealand, Darwin collected insects, shells, fish, rocks and a gecko. His detailed observations were carefully recorded in his journal of the Beagle expedition, which was published to much acclaim in 1839.

Flightless birds, giant snails, walking bats – many of New Zealand's plants and animals are unique. There are almost no native mammals, but lots of frogs, lizards, and land snails. Some species are similar to plants and animals in the other lands once joined to New Zealand. What is the explanation for this?

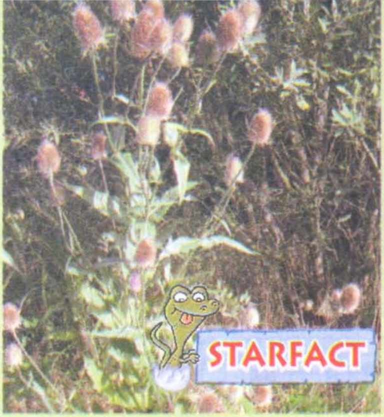
They are collecting insects...

About 85 million years ago, New Zealand broke away from the Gondwana supercontinent, carrying with it a cargo of plants and animals. Some of today's plants and animals may have evolved from those living there at this time. Many plants and animals have arrived more recently. This helps explain why there are few mammals. Only creatures that flew, or were light enough to be carried by the wind, or small enough to arrive on floating material, could cross the ocean between New Zealand and other lands.

Kiwi

What do we know of Darwin's visit to Australia?

Charles Darwin arrived in Australia on 12th January, 1836. During the 61 days he spent in Australia, Darwin visited Sydney, the inland settlement of Bathurst, Hobart Town in Tasmania, and King George's Sound in Western Australia. Sydney's roads, houses and even the shops all met with Darwin's enthusiastic approval. Beyond Sydney, he found the landscape arid and sterile, and the vegetation unappealing. Bad weather delayed the Beagle's departure from Hobart by 12 days, allowing Darwin to continue his natural history studies, and collect specimens of fossils, rocks, flora and fauna. He collected shells, barnacles, 10 species of fish and 66 species of insects, many of which were unknown to British scientists at the time, during the remainder of his stay in Australia. Darwin's writings are rich in observations of Australia's landscape, fauna, flora and people. These, and the insights he gained from his Australian associates, contributed to the development of his theories and ideas.



Teasel Plant

Mutant Teasel

Mutants are variations in a species brought about by a sudden change in the DNA. The teasel plant for example, has undergone mutation into the Fuller's teasel. A normal teasel plant has a curved spine on the seed head, but Fuller's teasel has a straight spine. Mutations are one of the causes of variations in a species.

Why are variation, inheritance and competition important in evolution?

Charles Darwin's theory of evolution through natural selection is based on variation, competition, and inheritance. The reason that variation is important is because there is competition among members of the same species for food and space. Moreover, more offspring are produced than can be supported by the available food and space.

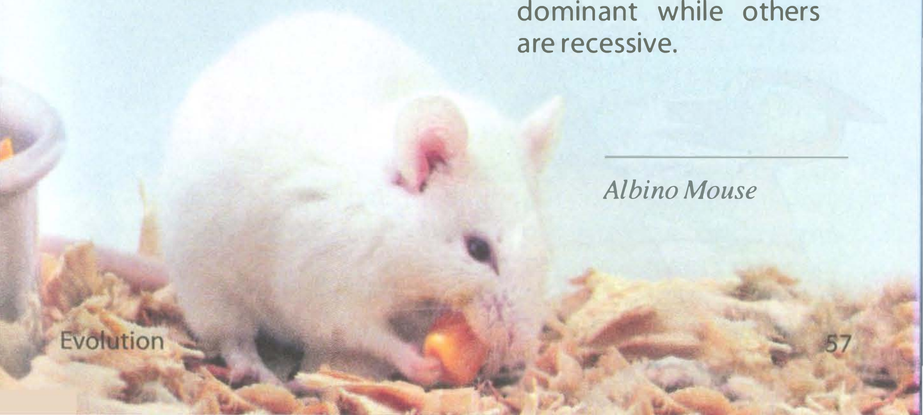
Variation refers to the fact that some combinations of traits will give some members of a species an advantage over others in this competition for survival. The offspring of the survivors in the competition inherit the strengths of their parents and this leads to evolution.

Why did his theory of heredity become a problem for Darwin?

Darwin believed that acquired characteristics are inherited, but gave more importance to variation and selection of the fittest in his theory of evolution. Darwin made a major mistake when he thought that the characteristics of parents were blended in their children. If this were so, strong characteristics would be diluted, and the advantage gained by variation would be lost. However, Darwin was not able to come up with another explanation.

Darwin conducted many experiments into the effects of crossbreeding and inbreeding in both plants and animals. He noticed that when albino mice are crossbred with normal mice, the colours do not blend, but he thought that this was just an oddity. Darwin also found that inbreeding often resulted in weaker, sicklier descendants. In his own life, he married his first cousin, and their children suffered the disadvantages of inbreeding. Three of his ten children died before they were 11 years old, and the rest were rather sickly.

Darwin noticed that very often, children do not resemble their parents, but may look like their grandparents or other relatives. He could not give an explanation for this. However, scientists later explained this by saying that all our characteristics are determined by our genes, and some genes are dominant while others are recessive.



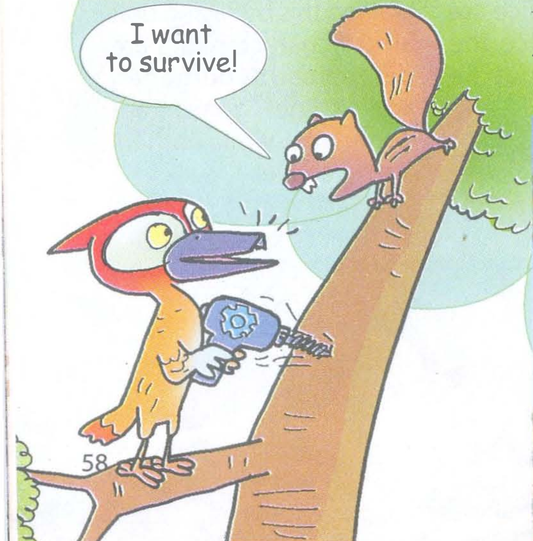
Albino Mouse

Why do we say all living things struggle for existence?

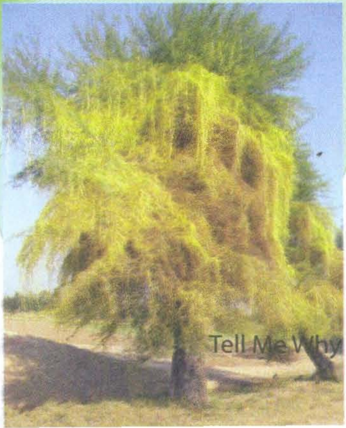
Darwin suggested that an organism's struggle for existence determines why some species' survive, and others become extinct. The great number of variations in species has allowed plants and animals to become beautifully adapted to their environments.

Darwin provides examples of these adaptations. He mentions the beak of a woodpecker, which allows it to gather insects for food. Another example is the structure of a parasite, which allows it to attach itself to and feed off of another organism. Darwin pointed out the ability of a beetle to dive into the water to gather food. These adaptations illustrate how unique characteristics of particular organisms have developed, allowing them to thrive in their specific environments. The most advantageous characteristics are preserved, and passed on to offspring. Darwin explains that the presence of these useful adaptations in organisms is the result of natural selection.

According to Darwin, although nature can provide an abundance of food and shelter to its inhabitants, it can also be destructive, causing a struggle for existence. The constant competition for existence compels all organisms and species to strive to outlive others, and successfully leave offspring for the survival of the species.



A Parasitic Plant Growing on an Acacia Tree



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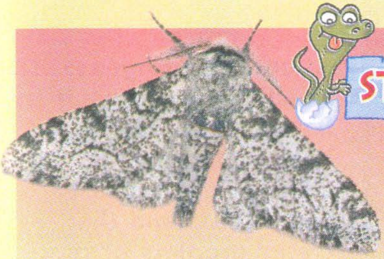
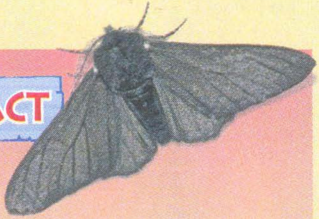


White Bodied Pepper Moth



Black Bodied PepperMoth

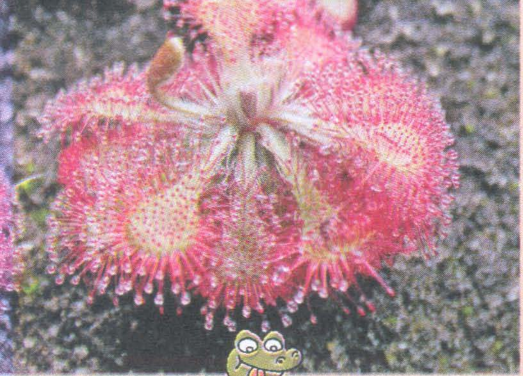
Concealing Colours

The pepper moth has pale coloured wings that are not easily seen against the lichen growing on tree trunks. This camouflage provides the moth protection from insect eating birds. However, during the Industrial Revolution in England, pollution killed off the lichens. The tree trunks turned black with soot from factories. It was noticed that the pepper moths' wings gradually turned darker too, and in time, dark coloured pepper moths became common.

What is natural selection?

Natural selection is when a living thing is born with some feature that's different from the rest of their species-for example more fur, or a longer neck or legs-that gives them an advantage, and helps them live better and longer in their environment. These creatures pass on this difference to their offspring, and their offspring pass it onto their offspring, until finally, a different species is formed.

Here is an example of natural selection at work. Millions of years ago, the only vertebrate species in the world were fish, all of which lived underwater. Competition for food was intense. Some species of fish that lived near the coast developed a strange mutation-they developed the ability to push themselves along in the mud and sand on the shore with their fins. This gave them access to food sources that no other fish could reach. The advantage gave them greater reproductive success, so the mutation was passed along. This theory of natural selection is the basis of Darwin's theory of evolution.



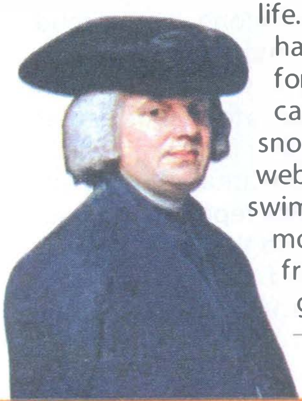
STARFACT

Hungry Plants

Sundews are generally small plants growing in flat rosettes. The leaves, bear tentacles that radiate in all directions, each bearing a gland that secretes droplets of mucilage, giving the plant its dewy appearance. Insects are attracted by the look and smell of the leaves and become mired in the sticky 'dew'. The struggling victim stimulates the tentacles to bend and touch it, drawing it closer to the leaf. At the same time glands in the leaf secrete powerful digestive enzymes. Sundews extract nutrients from the insect very quickly, taking from 24 to 48 hours. When finished, the tentacles release the carcass, ready for another meal.

What is natural theology?

It is a fact that all plants and animals are superbly adapted to their climate, surroundings, and way of life. The polar bear has thick white fur for warmth and camouflage in the snow, ducks have webbed feet for swimming, and moles have strong front feet for digging. According to Darwin, these adaptations were the outcome of natural selection. However, an English clergyman, William Paley, had another theory called natural theology. According to him, the existence of adaptations proves the existence of a Creator who is responsible for these adaptations, and by studying natural history, we can understand the nature of God.



William Paley

What are some examples of adaptations?

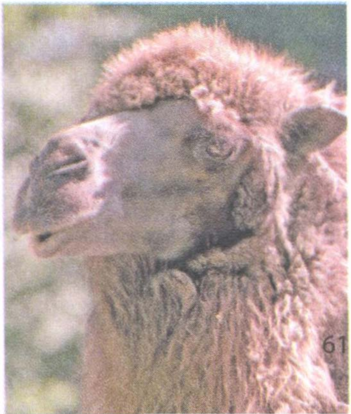
Adaptation is the ability of a living being to adapt to its environment by changing its function or behaviour. One of the very well-known examples of animal adaptations is that of the ships of the desert, the camels. To protect itself from the blowing sand of the desert, a camel has two rows of long and thick eyelashes. Its nostrils can be closed to prevent the blowing sand from getting in. Its hooves with broad and leathery pads create a snowshoe effect, and prevent a camel from sinking in the sand. Its hump that stores fat helps a camel sustain itself for long spans without food and water.

Polar bears, which inhabit the polar regions of the planet, have adapted to the aquatic environment. They have a thick layer of fat, and dense layers of fur to protect them from the cold. Giraffes exhibit some interesting adaptations that help them survive in the savannas. Their fringed tails help keep flies and insects away. Their long legs and long neck provide them with the height to reach tall trees. The long tongue helps a giraffe strip off leaves, while its tough lips protect it from thorns.

Polar Bear

A unique animal adaptation observed in certain fish is that of counter shading. Pelagic fish are often light coloured at the bottom and dark towards the top. Due to this colouration, the birds flying atop cannot see the fish easily due to their dark colour, while the fish swimming below them do not easily see their light coloured bodies.

Camel



STARFACT

Not One But Three

The small bird chiff chaff, the willow warbler, and the wood warbler have distinctly different songs. However, since they looked somewhat similar, it was thought that they were all of the same species. It was an English naturalist, Gilbert White, who first noticed that they were actually

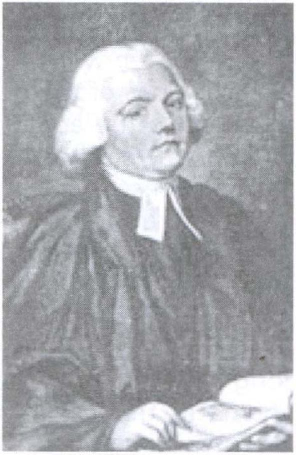
Chiff Chaff

How are new species formed?

Species don't simply 'appear' all the time. The development of new species takes thousands of years. Geographic isolation seems to be one of the main ways this happens. This geographic separation from others of their species seems to be what made different species evolve on the Galapagos Islands. The separation of the islands from the mainland may have led to those animals evolving into new species.

When a group of individuals is separated from the rest of their species for a long time, the individuals can evolve different traits. The longer the group is isolated from the rest of the species, the more likely it will evolve into a new species. One example of this has been seen in fish species in the lakes of Switzerland, Great Britain, and Scandinavia. Almost every lake has different forms, believed to have evolved from one species.

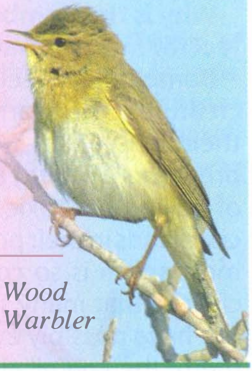
Changes in genetic compositions can create a new species. Cross breeding of two species of the same kind of animal might produce a new kind of animal.



Gilbert White

three different species. The differences in their songs acted like an isolating mechanism when the female wanted to attract the male during mating, and this ensured that the species remained distinct.

Willow Warbler



Wood Warbler

Lungfish

What are living intermediates?

Contrary to common belief, most fossils are not of extinct types of animals. Most fossils are very similar and often totally identical to creatures living today. There are also transitional fossils which are fossils that give us information about a transition from one species to another. The transitional fossil is interesting because it tells us details of how the change happened.

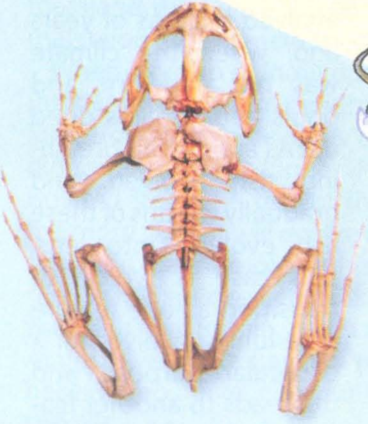
Some animals that are alive today help us understand transitional fossils better, and these animals are known as living intermediates. An example is the lungfish, which is a fish that breathes with a lung as well as by gills. Lungfish must have evolved millions of years ago, when the climate was hot and dry, and pools and streams dried up. As a result, air breathing fish evolved, and gradually the fins of these fish evolved into legs. This case is typical of transition as one feature –the lungs- evolves for a particular purpose, and this leads to another feature, the legs.

Why is the Bombardier beetle a subject for much debate?

Bombardier beetles are remarkable creatures. They earned their name from their ability to defend themselves against predators by firing an explosive mixture of boiling-hot toxic chemicals from special glands in their posterior. This defence mechanism is so complicated and specialized that many scientists felt it could not have possibly evolved. According to them, the chemicals that cause the explosion are produced separately and the explosion occurs when they are mixed. Some scientists claimed that there is no evidence that these chemicals once served another purpose.

The evolutionists however have come up with an evolutionary pathway that accounts for the bombardier beetle's defence mechanisms. They claim that the chemicals that cause the explosion have other uses in living bodies and were already available for natural selection.

Bombardier Beetle


Skeleton of Frog

STARFACT

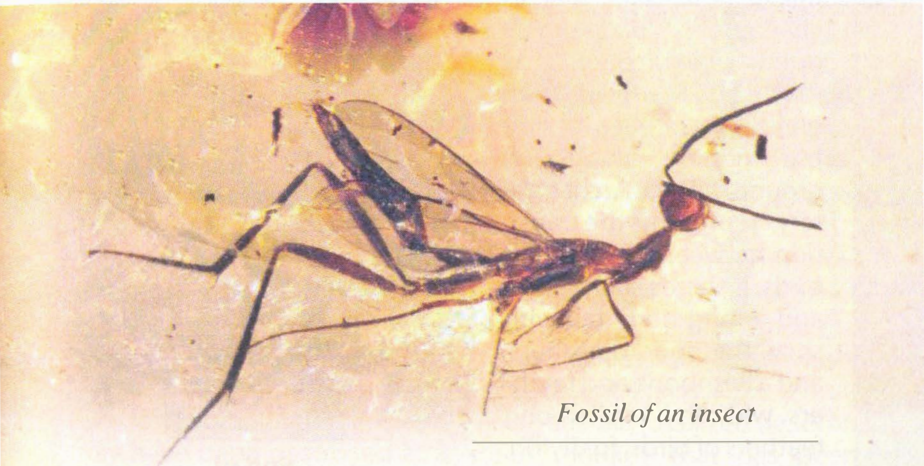
A Great Leap Forward

Frogs evolved from fish that swam with a side to side motion. They gradually developed longer hind legs for faster swimming with a kicking motion. In time, these long legs became used for jumping. Today, the frog has a specialized skeleton which allows it to make huge jumps on land.

STARFACT

Stiff Resistance

Darwin's book 'On the Origin of Species,' met with much resistance. People did not take kindly to the idea of natural selection. The pious hated Darwin because they believed Man was created by God, and was not a descendant of the apes.



Fossil of an insect

Why are fossil intermediaries important?

Fossil intermediaries are important because they reveal how new groups evolved from existing ones. According to estimates, only one fossil species has been found for every 20,000 species that have lived. This makes the chances of finding an actual ancestor of a living group very small indeed. Fossil intermediaries have characteristics that are intermediate in nature to organisms that existed both prior to it and after it. For example, it is now believed that snakes evolved from four-legged lizards. They lost their legs when they began to slither. A very large number of intermediary forms in the fossil record provide evidence for this.

Why is the Archaeopteryx significant?

The first complete skeleton of the Archaeopteryx was discovered in Germany in 1861. Living around 150 million years ago, the Archaeopteryx had developed flying abilities that may have evolved from gliding out of trees, or simply running along the ground. The Archaeopteryx represents the transition between reptiles and birds. It shares sharp teeth and a long bony tail with small theropod dinosaurs, and a wishbone and feathers with the birds. Long feathers of birds, for flying, probably evolved from the body feathers of the Archaeopteryx. They also had three fingers that they used for climbing. These fingers evolved into hooks on the wing of the modern moorhen chick, and are used for climbing too.

Fossil of An Archaeopteryx

STARFACT

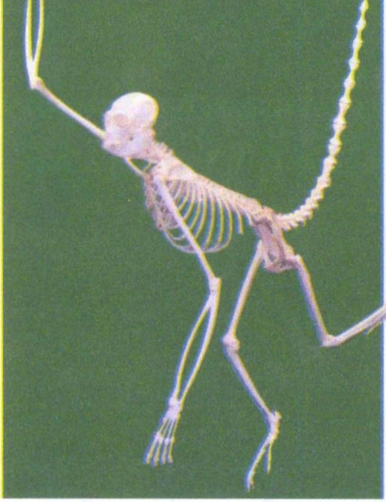
End of Mesozoic Era

The Mesozoic Era ended when a large meteorite crashed on the Earth. The soil and rock that were blasted into the air would have blocked out sunlight. The lack of sunlight would have killed plants, and the lack of plants would have killed off animals that depended on plants for food, leading to their extinction.

Why have missing links in fossil records affected the study of evolution?

Intermediary fossils help us trace the evolution of new groups. However, scientists often find that there are gaps of time in the fossil record. 19th century evolutionists referred to these periods in which fossils were still lacking as 'missing links' in the 'chain of evolution'.

Such gaps are often the result of changing conditions in the distant past. For long periods of time, most individuals in some species may not have survived long enough after their deaths to become fossils because they were eaten by predators. The few fossils that were formed may have been destroyed at a high rate by increased erosion in particular regions. Gaps in the fossil record are sometimes due also to the simple fact that we have looked for them in the wrong places. In fact, scientists have recently unveiled a 47-million-year-old fossilized skeleton of a monkey that has been hailed as the missing link in human evolution.



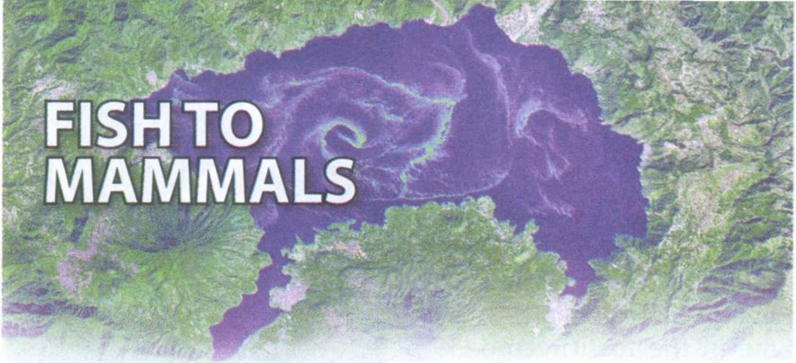
Skeleton of a Spider Monkey

STARFACT

Lost and Found

Called 'Old Four Legs' and the 'Living Fossil', the Coelacanth is a fish that was thought to be extinct. In 1938, a live coelacanth was fished out of the ocean, proving that a species can survive for 200 million years without leaving behind any fossils!

FISH TO MAMMALS



Blue-Green Algae in Lake Atitlan, Guatemala

Why is the sea called the cradle of life?

The sea is the cradle of all life which began 3.5 billions of years ago. Today, scientists have narrowed in on the hypothesis that life originated near a deep sea hydrothermal vent. The chemicals found in these vents, and the energy they provided, could have fuelled many of the chemical reactions necessary for the evolution of life. The earliest forms of life were single-celled bacteria and cyanobacteria, also known as blue-green algae. Over time, these bacteria trapped fine sediments and formed layers that built up on top of each other to form mounded and laminated living structures called stromatolites.

By about 2-billion years ago, these or-

STARFACT

Sea Scorpion

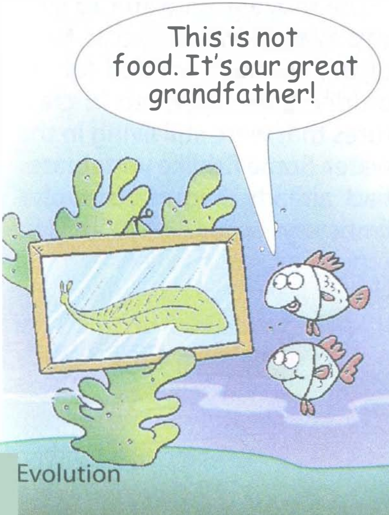
The discovery of a giant fossilized claw from an ancient sea scorpion indicates that when alive, it would have been about 2.5 metres long. The researchers said the scorpion, which belonged to a group called arthropods, lived between 460 and 255 million years ago in water, and would have been among the top predators in its environment, feeding on early vertebrates and arthropods.

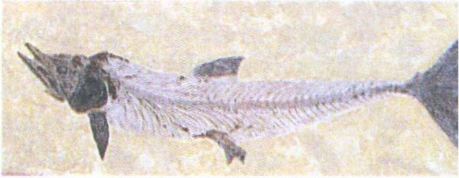
ganisms, which through photosynthesis and respiration absorbed CO_2 and released oxygen, had begun to oxygenate the Earth's atmosphere. With more oxygen present in the air, living organisms evolved, and became increasingly complex and diverse.

Today, there are about 1.5-million documented species of living things, out of an unknown total of perhaps something between 30-million and 100-million species - and it all began on the ocean floor!

What are the characteristics of early fishes?

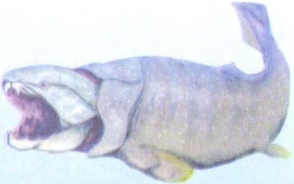
The first vertebrates on the planet were fish, and they provided the basic 'body plan' subsequently elaborated on by hundreds of millions of years of evolution. The first fish-like creatures to leave an impression on the fossil record appeared during the middle Cambrian Period, about 530 million years ago.


This is not food. It's our great grandfather!


An Extinct Predatory Salmonoid Fish

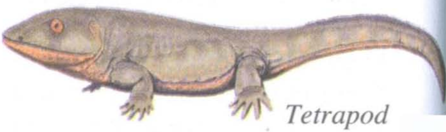
The most famous of these, Pikaia looked more like a worm than a fish, but it had four characteristics crucial to later evolution. It had a head distinct from its tail, and bilateral symmetry, which meant that the left side of its body looked like the right side. V-shaped muscles were a third feature, while the fourth and most important was a nerve cord that ran down the length of its body. Because this cord wasn't protected by a tube of bone or cartilage, Pikaia was technically a 'chordate' rather than a vertebrate, but it still lay at the root of the vertebrate family tree.

Powerful Predator



A prehistoric fish, the Dunkleosteus, might have been the owner of the most powerful jaws in the whole history of life. This creature was an armour plated fish that could be up to 9 metres long. It was streamlined and shark-like. Dunkleosteus lacked true teeth. Instead, it had two long bony blades that could snap and crush almost anything. Dunkleosteus may have been one of the earliest animals to exist as male or female.

Lchthyostega



Tetrapod

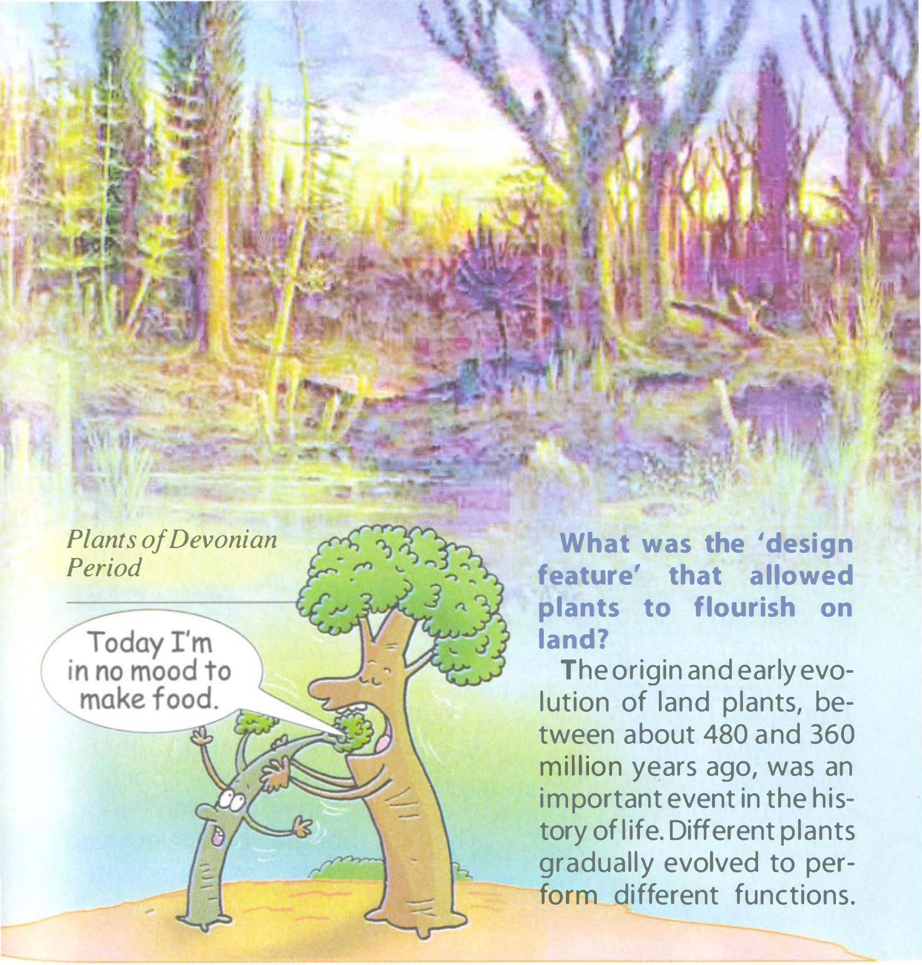
How did the movement of animal life from water to land occur?

One of the most important milestones in the evolution of life is that, the first animals made their way from water onto land. During that Period, known as the Devonian Period, the world was changing dramatically. Complex plant ecosystems formed on land, the first woody plants appeared, and the water's edge was becoming a new kind of environment.

The move from water to land was a very gradual process, Most of the changes needed for life on dry land happened in creatures that were still living in the water. Some fishlike vertebrates had already begun to evolve limbs by around 400 million

Daddy, Mummy - Good Bye!

years ago - they were called 'lobe-fins'. They had fins that looked like fleshy paddles, and lungs as well as gills. These lobe-fins evolved to become the earliest tetrapods– four-legged animals that walked on land. The four legs really evolved for navigating swampy wetlands- not as a means of moving to land. But once on land, the animals found their limbs a survival advantage there, too. One of the first vertebrates whose remains date from about 364 million years ago, is called Ichthyostega... and this move was one of the landmarks in evolution.


Today I'm in no mood to make food.

Plants of Devonian Period

What was the 'design feature' that allowed plants to flourish on land?

The origin and early evolution of land plants, between about 480 and 360 million years ago, was an important event in the history of life. Different plants gradually evolved to perform different functions.

The leaves were designed for photosynthesis, the stem for support, the roots to anchor the plant, and absorb water and minerals from the soil. The new plant forms had a system of minute tubes or vessels, and are called vascular plants. These tubes carried water and nutrients from the soil to the different parts of the plant.

Plants were now able to produce their own food through a process known as photosynthesis, and to reproduce. They now multiplied rapidly, to provide more food for new forms of animal life.

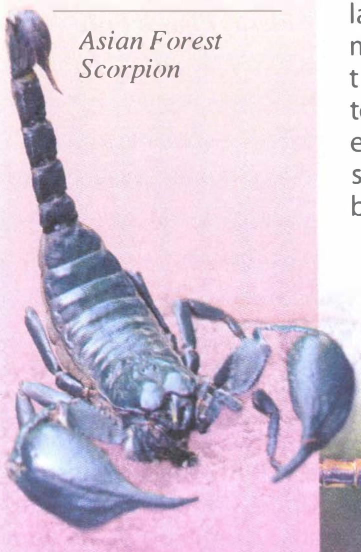
Velvet Worm

Club Mosses

Why were arthropods considered to be the first land animals?

The first arthropods appeared during the early Cambrian Period. They are thought to have evolved from annelids, or segmented worms between 500 and 600 million years ago. Perhaps the best known early arthropods were the trilobites, which were creatures that lived on the muddy bottoms of shallow marine environments. Based on fossil evidence, the first land animal was a myriapod arthropod.

Arthropods became the world's first land animals some 300 million years ago. They were the first animals to have jointed appendages. Joints permit powerful movement, aid in locomotion, and can be modified to serve many functions. In fact, the name arthropod means jointed foot. The first arthropods on land were millipedes, followed by scorpions, spiders, and eventually, insects. Arthropods were also the first organisms to evolve wings.



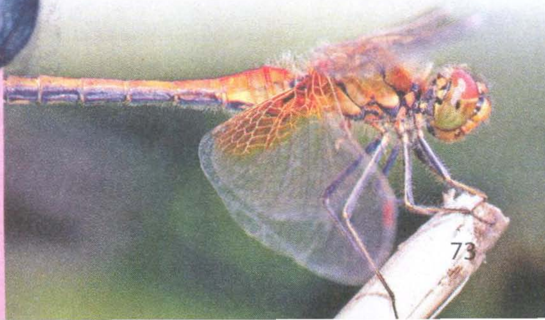
Asian Forest Scorpion

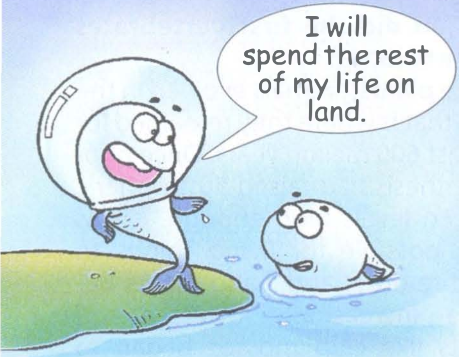
When did the first vertebrates move to land?

Like plants, animals evolved in the sea - that is where they remained for at least 600 million years. Once photosynthesis had raised atmospheric oxygen levels high enough, it was then possible for living things to venture onto land. Land plants became increasingly diverse, and plants like club mosses began to grow in drier environments.

The first land animals were invertebrates which were animals that did not have a backbone. Different types of invertebrates, like scorpions and dragonflies were probably the first land animals. These early land animals had to solve the same problems that plants faced when they moved to the land- water conservation, gas exchange, reproduction and dispersal, and the fact that water no longer buoyed them up against the pull of gravity. Like plants, animals evolved waterproof external layers, internal gas exchange

Dragon Fly




I will spend the rest of my life on land.

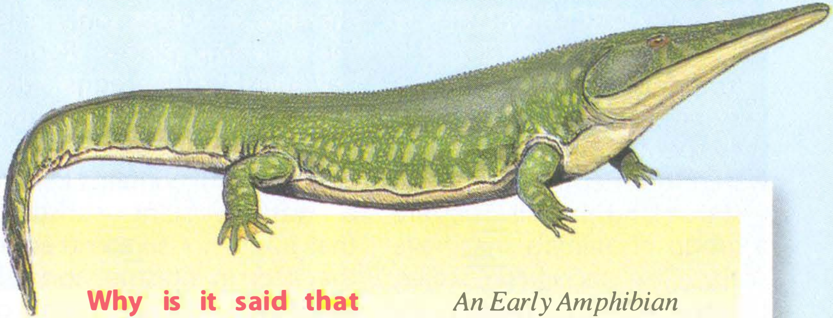
How did amphibians evolve?

Amphibians are believed to have evolved from fleshy finned fish. These fish were carnivorous, and lived in both salt and fresh water. They had muscular fins, and organs similar to lungs.

The first amphibians were fish, with poorly-developed legs that crawled out of the water around 300-390 million years ago, during the Devonian Era. The reasons for evolving legs include the need to migrate often from pools of water which often dried up, or to find more food. Over time, amphibians evolved into air breathing creatures with four limbs that could walk, and breathe on land. Their eggs and tadpoles remained in water, and adults lived both in water and on land.

Fleshy Finned Fish

systems, ways of reproducing that did not involve water, and strong support systems in their bodies that allowed them to move about on land. The first animals with backbones, or vertebrates, moved on land around 370 million years ago. The first vertebrates on land were amphibians.



An Early Amphibian

Why is it said that amphibians dominated the Earth 300 million years ago?

Amphibians evolved from fish about 400 million years ago, when the amount of dry land on Earth increased greatly. Certain fish adapted to these changing conditions by gradually developing limbs to crawl with, and lungs to breathe with.

The early amphibians evolved into two types. The first types were small and weird-looking – and were known as the lepospondyls, while the second type was as big and reptile-like and was known as the temnospondyls.

The lepospondyls were mostly aquatic or semi-aquatic, and more likely to have the slimy skin characteristic of modern amphibians. Some of these creatures resembled small snakes, others were reminiscent of salamanders, and some were simply unclassifiable. A good example of the last is a metre long lepospondyl that had a huge, boomerang-shaped skull, known as the diplocaulus.

It is only in the late Carboniferous Period, from about 310 to 300 million years ago, that the first true amphibians appeared. By this time, some of them had attained relatively monstrous sizes. For a time these creatures dominated the Earth. In fact, amphibians ruled the Earth before any reptiles or mammals even existed.

Why are reptiles considered the first true land animals?

Amphibians were the first vertebrates to live on land, but they spent a part of their life in water too. Reptiles were the first true land animals. They are a group of animals that have scales, or modified scales, breathe air, and usually lay eggs. Crocodiles, snakes, lizards, and turtles are all examples of reptiles. Reptiles separated from their water-dwelling ancestors and climbed onto land during the Paleozoic Era, over 280 million years ago.

Unlike amphibians, reptiles laid their eggs on land, and their young were nurtured on land too. Amphibian eggs have a gel without any hard covering surrounding them. This means that they can be laid only in water or damp places. Reptiles have hard, leathery eggs laid on land, or they keep eggs in their bodies until they hatch.

Reptile skin contains keratin, a water-resistant substance that traps moisture and scales that keep in moisture and help avoid skin damage. Living on land meant limited access to drinking water, so reptiles' kidneys have adapted. They conserve water by producing less urine in more concentrated forms. Adapting lungs in place of gills was a significant step in reptiles' migration to land. Reptiles are born with fully developed lungs. All these features made it possible for reptiles to be the first truly land animals.

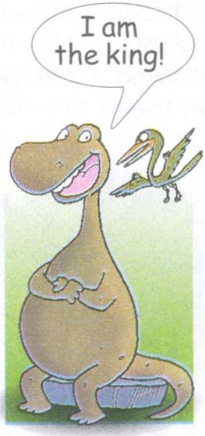
A Mesozoic Scene

Tuatara

Turtle

Why are dinosaurs called the ruling reptiles?

The Jurassic Period started around 205 million years ago, and is known as the time when dinosaurs, who were reptiles, ruled the Earth. Dinosaurs were now much larger, which clearly put them at the top of the food chain. Some of the largest dinosaurs of the Jurassic age were the herbivore plant eating sauropods. Thanks to the abundant plant life, massive herbivores such as the brachiosaurus, diplodocus and apatosaurus had no shortage of food. The fiercest among the carnivorous dinosaurs were extremely large theropods like the allosaurus and the ceratosaurus. The allosaurus was probably the top Jurassic predator of its time, and with the largest specimen coming in at a length of over 9 metres and its prey were most likely the large herbivores such as the sauropods. Flying reptiles like the pterosaurs were still the dominant air species. It was the first feathered flying species, and clearly an evolutionary step towards the bird species. Marine reptiles consisted mainly of the plesiosaurs, ichthyosaurs, large marine crocodiles, variations of modern day sharks, as well as cephalopods which are relatives of today's squid and octopus species.

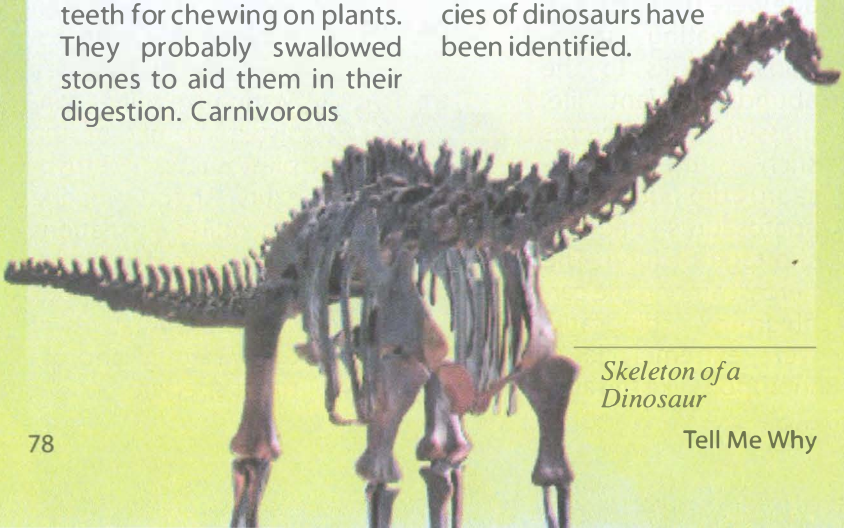

I am the king!

Which were some different types of dinosaurs?

There were many different kinds of dinosaurs. The smallest types were about the size as a chicken, and the largest were over 100 feet, or 30 metres long. Some ate only meat and were known as 'carnivores'. Some ate only plants and were herbivores. Others ate both plants and meats and were 'omnivores'.

Herbivorous dinosaurs were usually larger in size, and had longer necks than the others as they evolved to scare carnivorous dinosaurs who hunted them for food. They usually lived in herds. They had short and blunt teeth for chewing on plants. They probably swallowed stones to aid them in their digestion. Carnivorous dinosaurs were large in size, and they usually walked on their hind limbs. They had long and sharp teeth for killing their prey, and ripping their flesh for food. Omnivorous dinosaurs were not as large as carnivorous dinosaurs. They usually walked on their hind limbs, but they did not have specific kinds of teeth as they consumed plants, animals, and even eggs.

Dinosaurs are also classified as being lizard hipped or bird hipped. Some common dinosaurs are the acrocanthosaurus, tyrannosaurus rex, spinosaurus, brachiosaurus, and diplodocus. Till now, more than 700 different species of dinosaurs have been identified.



Skeleton of a Dinosaur

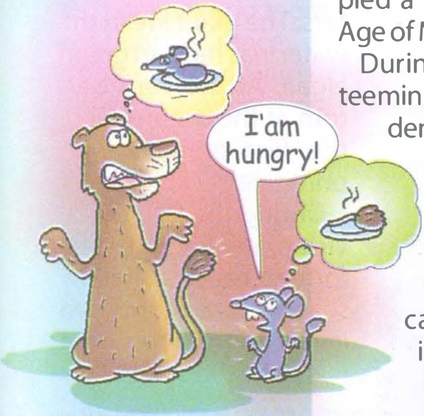
Mammals

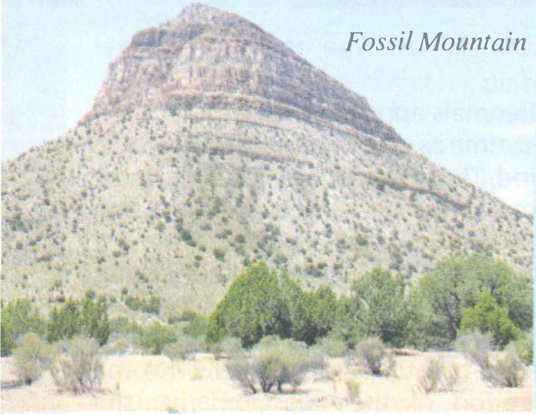
How did the Age of Mammals begin?

Mammals appeared first at about the same time as dinosaurs, in the Mesozoic Period. Throughout the Mesozoic, most mammals were small, fed on insects, and led a nocturnal life. Dinosaurs were the dominant forms of life on land during this time. This situation changed abruptly about 65 million years ago, when dinosaurs disappeared, with the exception of their descendants, the birds, probably as the result of a meteorite impact.

The epoch right after the mass extinction of the dinosaurs is called the Paleocene. At the beginning of the Paleocene epoch, the world was practically without larger sized terrestrial animals. This unique situation was the starting point for the great evolutionary success of the mammals. Only ten million years later, at the end of the Paleocene, they had occupied a large part of the planet, and the Age of Mammals had begun.

During this time, the landscape was teeming with small insectivorous and rodent-like mammals, medium sized mammals were searching the forests for any kind of food they could cope with. The first large mammals were browsing on the abundant vegetation, and carnivorous mammals were stalking their prey. It was a crucial time in the history of mammals.





Fossil Mountain

Ordovician Name

Rocks from the Ordovician Period were first found in Wales, so its name comes from a tribe of people who once lived in the area where the rocks were found. The Ordovician began about 490 million years ago, and lasted for about 47 million years.

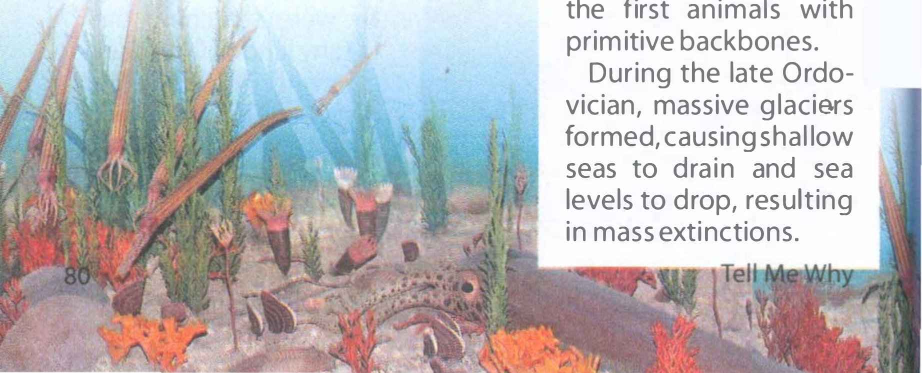
What is the Ordovician period?

The Ordovician Period began approximately 490 million years ago, with the end of the Cambrian, and ended around 443 million years ago, with the beginning of the Silurian.

Life was still primarily found underwater, but there were more different species than ever before. The trilobites did not die out with the mass extinction at the end of the Cambrian Period. They lived on, and many new species developed. New animal forms developed, too. The cephalopods became the dominant predators of this period. Cephalopods are a group of molluscs that are related to the octopus and squid. Sponges, corals and even primitive fish lived in Ordovician waters. The plant life in the water was red and green algae. At the very bottom of the oceans were the first animals with primitive backbones.

During the late Ordovician, massive glaciers formed, causing shallow seas to drain and sea levels to drop, resulting in mass extinctions.

Ordovician Flora and Fauna

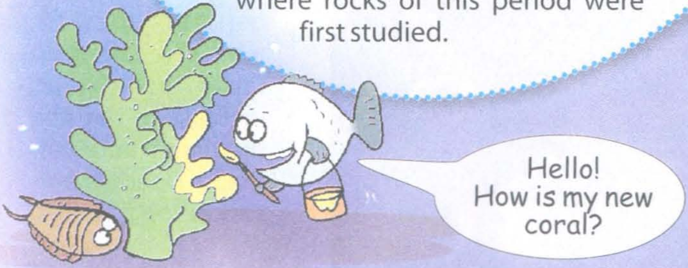


Fossilised Late Silurian Shallow Sea Floor Displayed in Bristol City Museum

What was the Silurian Period?

The Silurian Period started about 443 million years ago. Plants recovered from the first mass extinction, and colonized land. Plants were soon followed by terrestrial animals, such as spiders and centipedes. The climate during the early Silurian Period was mild over much of the Earth. Large shallow seas covered vast portions of the continental land areas. Shale, limestone, sandstones, and conglomerates and quartzites were widely deposited. At the same time, glaciers of the previous age melted, and new freshwater lakes, ponds and streams appeared. Fish soon moved into this new area. Coral appeared, slowly growing higher as the melting glaciers added to the ocean level. The oceans grew deeper and more open, and jawed fish soon made their appearance.

The Silurian Period is named after the Silures, an ancient people who lived in Wales, where rocks of this period were first studied.


Hello!
How is my new coral?

What was the Devonian Period?

The Devonian Period lasted from 417 million years ago to 354 million years ago. It is named for Devon, England where the old red sandstone of the Devonian was first studied.

The warm temperatures during this period made life on land particularly good for plants. They developed vascular tissues to carry water and food through roots and leaves. The most important development was the seed. The plant-covered lands made a good home for the first wingless insects and spiders.

The Devonian Period is known as the Age of Fishes. It is famous for the thousands of species of fish that developed in Devonian Seas. The Devonian Period also ended with a mass extinction.

A Middle Silurian Vascular Plant

What were the changes during the Carboniferous Period?

The Carboniferous Period began about 359 million years ago. Most of the land on Earth was warm and swampy, and continents were covered with big forests of ferns. When these ferns died, they formed thick layers of dead plants that eventually turned into coal. Most of the coal in the world today comes from ferns that grew during the Carboniferous Period.

There was an abundance of oxygen in the air, which resulted in faster growth and increase in the size of plants and animals. Deadly poisonous centipedes,

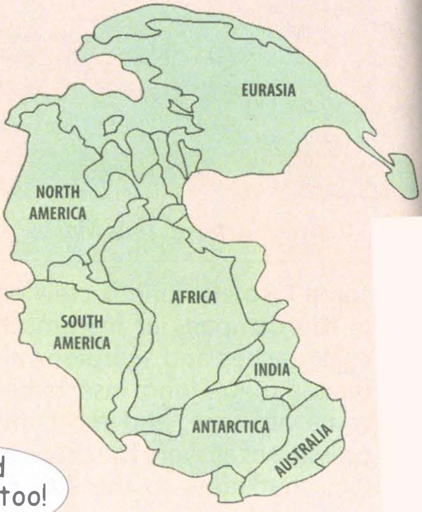
Lower Carboniferous Marble

some 1.8 metre length, crawled in the company of mammoth cockroaches and scorpions almost a metre long. Insects became airborne, and most impressive of all were the dragonflies that grew to the size of seagulls. Amphibians were also growing in size and diversity. There were predatory species that resembled modern-day crocodiles. Some of them developed into reptiles with the ability to lay eggs.

This is a carboniferous coal.

A Chimpanzee and its Baby

Hippopotamus



Pangaea

Why is it said that humans and chimpanzees share a common ancestor?

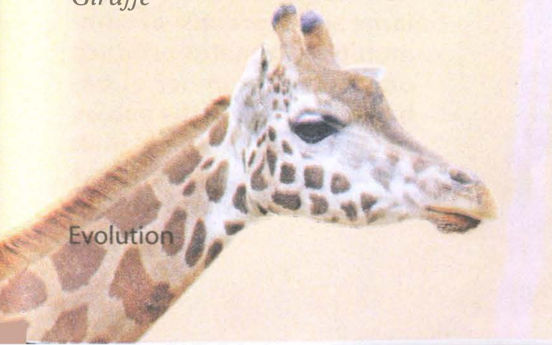
Molecular evidence showed very clearly that chimpanzees are our closest living relatives, and so, logically, we must share an ancestor in common at some point in the past. This common ancestor wasn't necessarily identical to modern chimpanzees- and probably lived 5 to 7 million

We are best friends..
...and cousins too!

Gazelle

years ago. The fossil Ardipithecus ramidus, dating 4.4 million years ago, may very well be the common ancestor of both humans and chimpanzees. It walked neither like us or chimps, and had instead, an intermediate form of walking. Shortly thereafter, the species diverged into two separate lineages. One of these lineages ultimately evolved into gorillas and chimps, and the other evolved into early human ancestors called hominids. It is believed that the earliest hominids lived around 4.4 million years ago in the humid forests of Eastern and Southern Africa.

Giraffe



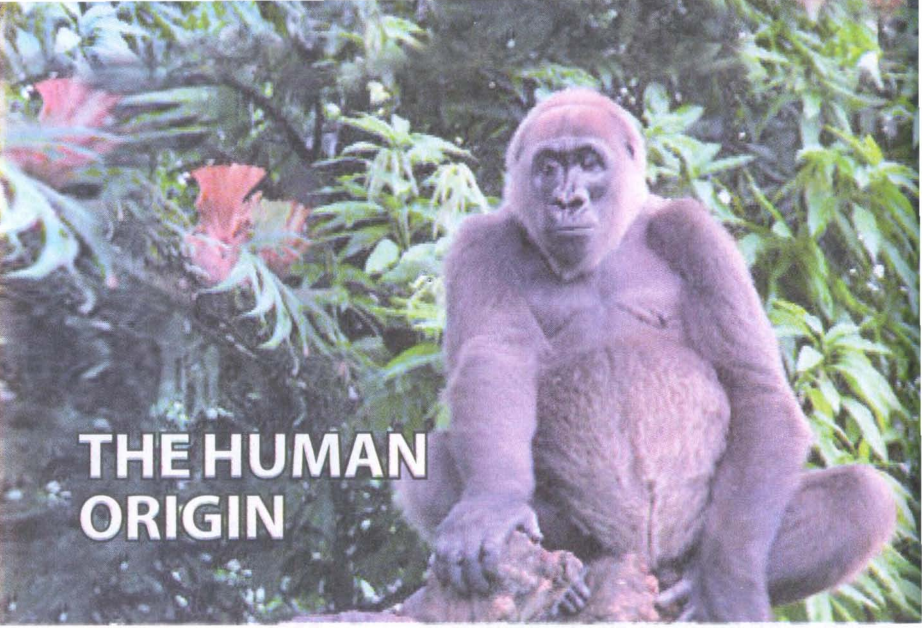
STARFACT

Lucy

In 1974, a skeleton was found in Africa. The bones were those of young female, approximately 20 years old when she died. Scientists named this 'young lady' Lucy. She is believed to be a hominid that lived 3.2 million years ago. The discovery of this fossil was significant because, it has provided us with a wealth of information about the ancestral line of human beings.

● *Manu Agarwal*

THE HUMAN ORIGIN



Why are a primate's forelegs important?

Primates are those species of mammals, which includes humans, which have evolved over a period of time. Primates are normally categorized by the five fingers they have on their hands and feet. They also have a large brain size, and they are social animals.

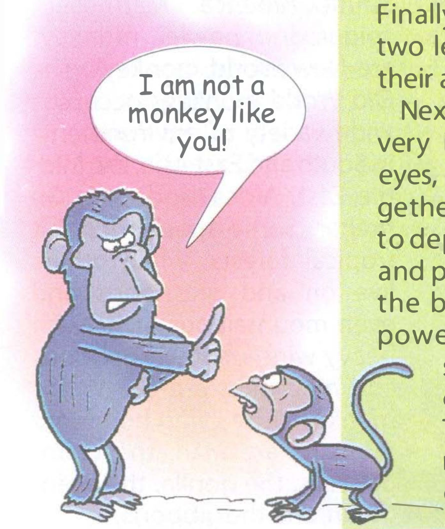
As primates evolved, they began to use their forelegs like arms, and their front

Chimpanzees

Family Life

Most primates, including humans, spend their lives in large social groups, or communities. Primates produce only a small number of babies at a time, and the babies feed on their mothers' milk for a long time. Family and social bonds are strong.

paws began to be used like hands to grasp and handle objects. Gradually, primates began to depend more and more on their arms and hands to look at, smell, and touch objects. This meant that they did not have to walk on all four feet, and as time passed, they started walking more and more on two legs, and their forelegs developed into arms and hands. This was an important step in the evolution of Man.


I am not a monkey like you!

Hominids

How did human beings develop according to fossil studies?

The first step in the evolution of human beings was when primates began to change in the arms, shoulders, and legs. Front legs were used differently from back legs. Primates started to use their forelimbs to swing from branches, and their hind limbs for walking. Finally, they started to walk on two legs, and they began to use their arms in different ways.

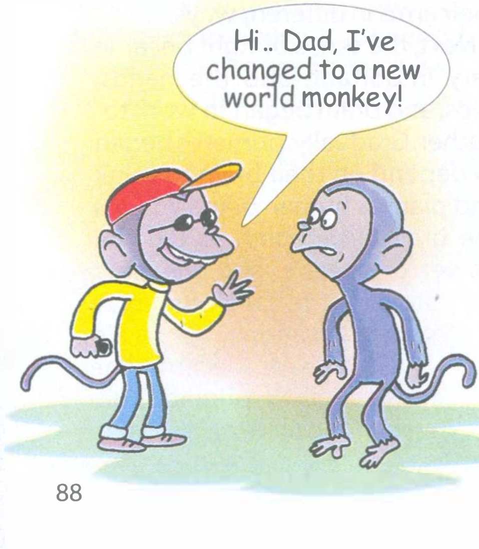
Next, the sense of sight became very important, and the hands, eyes, and brain began to work together. Gradually, primates began to depend on their brain to think and plan, as human beings do. As the brain developed, so did the power of speech, and the next step was the development of communication skills. Thus, humans became the most evolved primate species on the planet.

The Antarctic Ice Sheet

What are the major subdivisions of primates?

Scientists today have split primates into four divisions. They are the prosimians, New World monkeys, Old World monkeys, and Hominoid primates. The word Prosimian literally means 'pre-monkey' in Latin . They have a longer snout than the monkeys and apes. Lemurs, tarsiers, lorises and bush babies are all prosimians.

New World monkeys are limited to the tropical forests of southern Mexico, Central, and South America. Marmosets, spider and howler monkeys are New World monkeys. The Old World monkeys occupy a wide variety of environments in South and East Asia, the Middle East, Africa, and even Gibraltar. Some species inhabit tropical forests, while others live on arid grasslands and even mountainous areas with heavy winter snows. Baboons and macaques are Old World monkeys. The living hominoid primates are Man, the chimpanzees, the gorilla, the orangutan, and the gibbons.


Hi.. Dad, I've changed to a new world monkey!

Turkana Boy

Turkana Boy

The Turkana Boy is a youthful Homo erectus, whose fossil was discovered by Kamoya Kimeau and Richard Leakey in 1984. This individual is believed to have died at about 10 years of age. He lived 1.6 million years ago, west of Lake Turkana in northern Kenya. Turkana Boy is important because, it is the most complete early fossil discovered and provides many insights into the origins of modern humans.

● *Subhash Dixit*

How do primates differ from other mammals?

Primates are mammals too, but they differ from other mammals in several ways. To begin with, hands and feet have five sensitive and mobile fingers and toes that are used for grasping and holding things. Primates' teeth and gut are more suited for plant eating, and they have excellent eyesight. They have stereoscopic vision, and their brains are comparatively bigger and more complex than other mammals. Besides physical traits, primates are highly social animals who place an emphasis on learning in a social context, and on a highly structured family life.

Woolly Mammoths

Olive Baboon

How did primates evolve?

Primates are remarkably recent animals. The first primate- like animals were roughly similar to squirrels and tree shrews in size and appearance. They lived in trees in warm, moist climates. Along with the appearance of early forms of the placental mammals were primate species, that somewhat resemble modern prosimians such as lemurs, lorises, and possibly tarsiers. Monkeys evolved from prosimians. Apes apparently evolved from monkeys.

About 9 million years ago, the descendants of this group in Africa diverged into two lines-the gorillas and the line that would lead to humans, and chimpanzees.

STARFACT

Nutcracker Man

'Nutcracker Man' was the popular name given to a skull found by Louis Leakey, father of well-known fossil-anthropologist Richard Leakey, in East Africa in 1959.The name reflected the extremely powerful jaw muscles and large molar teeth it appeared to have had. Today, Nutcracker Man is believed to belong to the genus Australopithecus, a unique, extinct group of ape-like creatures.

Richard Leakey

Dominating Monkeys

Twenty million years ago, apes were more dominant and diverse than monkeys. Today, the reverse is true. Monkeys greatly outnumber apes in number and in species.

Around 6 million years ago, another divergence occurred which separated the chimpanzees from the early hominids or human like primates, that were our direct ancestors.

Why is Ramapithecus important?

Ramapithecus belongs to an extinct group of primates that lived from about 12 to 14 million years ago. Fossils of Ramapithecus were discovered in India and in Africa, beginning in 1932. Fossil evidence suggested that it had a short face, heavy jaws, and enamelled teeth like hominids. Its importance lies in the fact that it was regarded as a possible ancestor of Australopithecus and, therefore, of modern humans. Later fossil finds indicated that Ramapithecus was more closely related to the orangutan, and Ramapithecus is now regarded by many as a member of a group known as Sivapithecus.

Orangutan

STARFACT

George

Parts of a skull discovered in 1963 were believed to have belonged to a species of early Man. This fossil was named 'George' was estimated to be about 1.7 million years old.

● *Ullas Chandra*

Silverback Gorilla

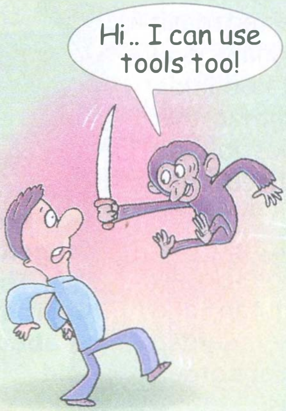
STARFACT

Hobbit

Hobbit or LB1 is a fossil of Homo floresiensis discovered in 2003 on the Indonesian island of Flores. The fossil consisted of an almost complete skull and partial skeleton. LB1 was an adult of one metre tall with an extremely small brain size. This 18000 years old fossil was found with stone tools.

Who are the closest relatives of humans?

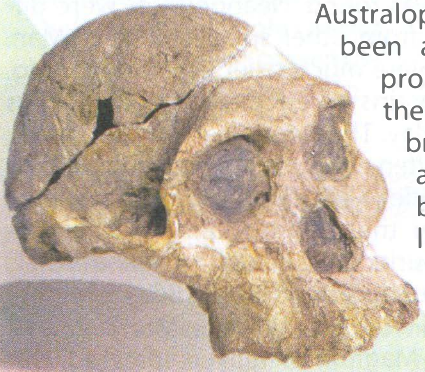
It has long been known that humans share a common ancestor with apes, but it was only in the last thirty years that techniques were developed to provide strong evidence in support of the theory that humans are more closely related to chimpanzees than they are to gorillas, orangutans, or gibbons. The DNA of a chimpanzee is 98% identical to that of a human being. However, our bodies adapted for walking


Hi.. I can use tools too!

Who were the Australopithecines?

Australopithecus was an early hominid which is now extinct. Fossil evidence suggests that these individuals lived from approximately four to two million years ago, after evolving on the continent of Africa. Since the fossils were recovered from South Africa, they were called 'South African man-apes,' or Australopithecines.

Australopithecines are believed to have been around 1-1.5 metre tall and probably fed on leaves fruits and the remains of dead animals. Their brains, were larger than those of apes, but smaller than human brains while their teeth were like human teeth. It is believed that Australopithecus eventually evolved into modern humans.



Skull of Mrs. Ples - a female Australopithecus Africanus

on two legs. This is possible because the lower portion of the human body evolved to facilitate load bearing, and balancing while walking upright.

Chimpanzees not only share most of our genes, they seem to be able to handle tools, and they are able to grasp language pretty well, too. Now researchers have found that we share a similar brain pattern when communicating. But in spite of these similarities, there are clear differences in body structure, intellect, and behaviour.

Neanderthal Skeleton

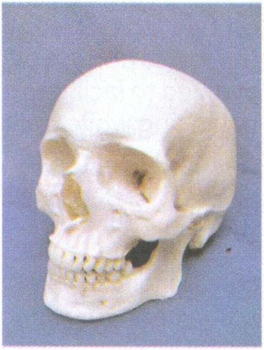
What do you know about Neanderthal Man?

Neanderthal Man first appeared in Africa about 200,000 years ago, and migrated to the rest of the world around 100,000 years ago. The name Neanderthal comes from the Neander Valley, where an early skull was found. Neanderthals were different from other species of early Man. They were much taller, and very strong. Their brains were actually larger than ours are today. They were marvelous hunters. They often used caves as their homes. They were adept at fire-making, and probably cooked their food, routinely. Neanderthals buried their dead. The Neanderthals died out by around 30,000 BC.

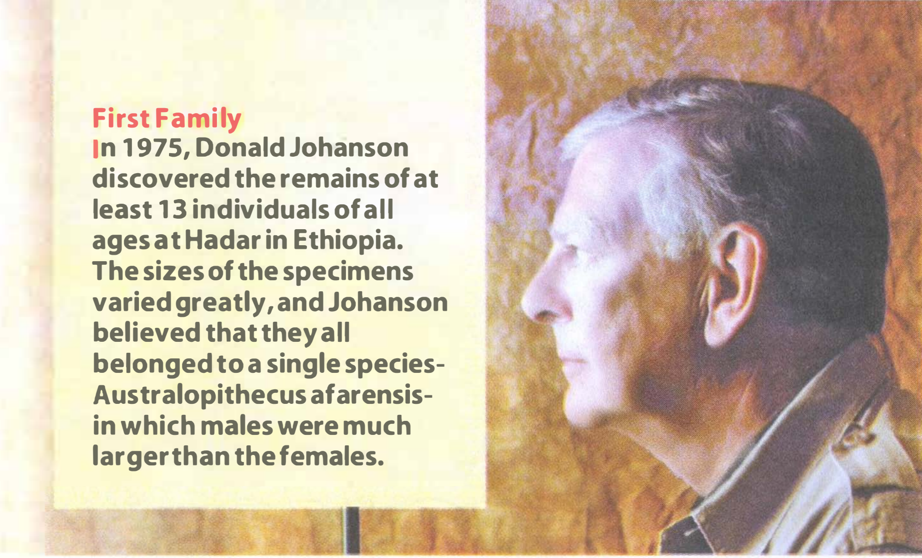
Who were Cro-Magnon Men?

Cro-Magnon Man lived some 40,000-10,000 years ago. Their remains were first found in France in 1868, and then throughout other parts of Europe. Cro-Magnon man was anatomically identical to modern humans, and differed significantly from Neanderthal Man whodisappeared in the fossil record shortly afterCro-Magnon's appearance.

Cro-Magnon Man was tall, and



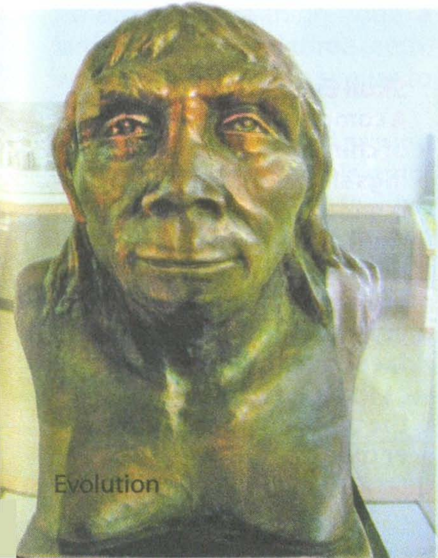
A Human Skull



First Family

In 1975, Donald Johanson discovered the remains of at least 13 individuals of all ages at Hadar in Ethiopia. The sizes of the specimens varied greatly, and Johanson believed that they all belonged to a single species-Australopithecus afarensis-in which males were much larger than the females.

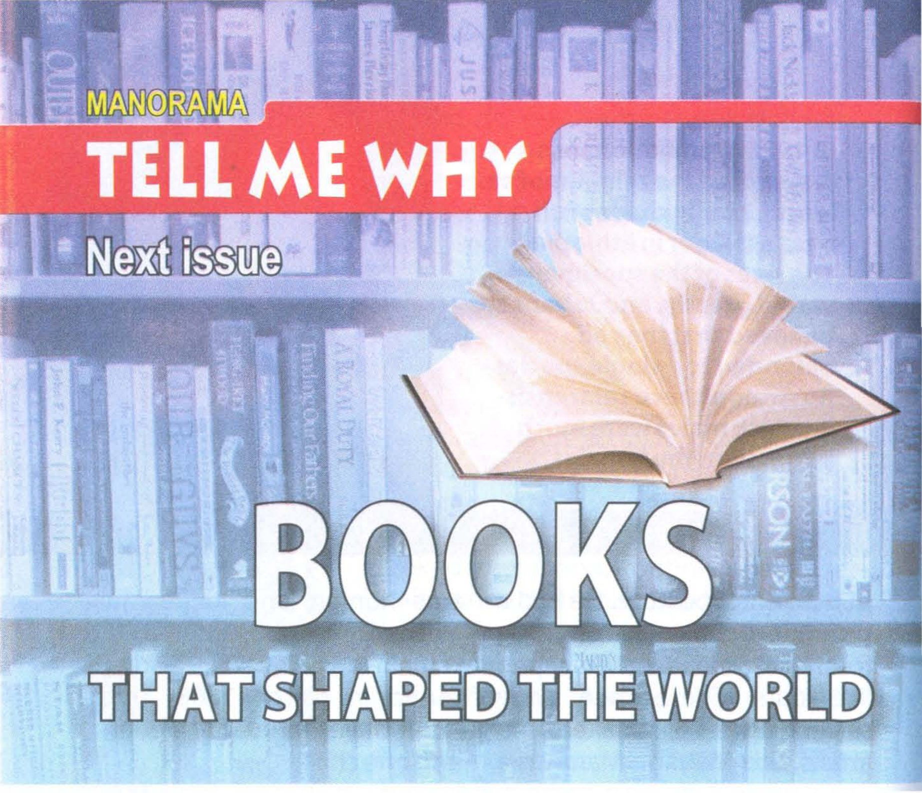
had an erect posture. He had a prominent chin, a sharply rising forehead, and a skull shaped like ours. These men were skilled hunters, toolmakers, and artists. Cro-Magnon Man was a true human, and looked just like us. He is represented by the remains of five individuals found in March 1868- three adult males, one adult female, and one child.



Who was Peking Man?

In the 1920's, an international team of scientists and miners unearthed the richest evidence of human evolution the world had ever seen. About forty skeletons of an ancient type of man were discovered, and since they were found near China's capital Peking, this type of man was called Peking Man.

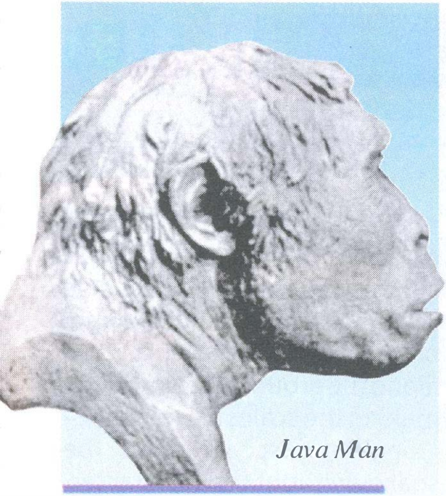
Peking Man



Peking Man seems to have been related to Java Man, since their skulls are of a similar shape. However, he probably lived at a later time. Peking Man had a larger brain than Java Man and seems to have been a hunter. The stone implements make it clear that Peking Man was able to make and use primitive stone tools to engage in labour, such as hunting for prey.

Skull Evolution

A comparison of the skulls of chimps and human beings shows that our brain is encased in a spherical skull that has no crest or ridge, as seen in the case of a chimp's skull. Moreover, the lower part of the face is not as protuberant as that of a chimp, while the teeth are much smaller than a chimp's teeth.



Java Man

Who was Java man?

Java man is the name given to a man-like creature whose fossils were discovered on the island of Java by a Dutch physician, Eugene Dubois, in 1892. He discovered a thigh bone, a large skull cap, and three teeth, which seemed to be similar to those of humans.

'Java Man' was hailed around the world as indisputable proof of human evolution. The leg bone shows clearly that Java man walked upright, and was not an ape, but a hominid. In fact, Java Man is considered to be the first hominid to spread out of Africa, with fossils found in Asia and Europe as well.

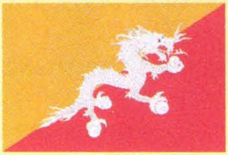
CLARIFICATIONS & CORRECTIONS

It is our policy to correct errors, and present differing views and clarifications about the contents in previous issues. Please send in your feedback, mentioning the title and page number.

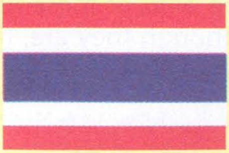
Hari Sanker S., a student of class 7, Coast Guard Public School of Daman, has pointed out a mistake in the December issue of Tell Me Why, Countries of the World. He writes that on Page 22, Bhutan's flag is wrongly captioned as the flag of Thailand.

Thank you Hari Sanker for your valuable feed back. Both the flags are shown below with the correct captions.

- Editor



Flag of Bhutan



Flag of Thailand

I Wonder Why?

The question of the month

Aren't there many little things you have wondered about, but didn't know whom to ask? Send us your questions, and we will give you the fascinating reasons behind the incredible mysteries of life.

Why do snakes move in a zigzag manner?

When snakes glide along, their bodies curve in zigzags.

The snake's spinal column is made up of a long chain of bones. Ribs join onto these bones. There may be as many as 300 to 400 bones in the backbone of the big snake, and ribs for nearly all of them. Now, these bones move with wonderful ease, but they can move only from side to side. The snake can twist from left to right, and it can raise the front portion of its body, into an upright position.

How does the snake move? Each pair of ribs joins on to a strong scale under the body of the snake, and controls it by a slender but strong muscle. It is on the ends of these ribs, hidden though they are, that the serpent rests. When it wishes to go forward, it moves its ribs in such a way that they cause its scales to stick to rough ground, or the bark of a tree. It rows along the ground, the rib-points making the scales act as oars.

Snakes just wouldn't be snakes without their characteristic slither. Known scientifically as 'lateral undulation', the creatures wiggle their bodies like a sideways wave and leave a perfect S-shaped track as they go.

● *K.P. Sukumar*

Zigzag or six pack?

MANORAMA TELL ME WHY - EVOLUTION

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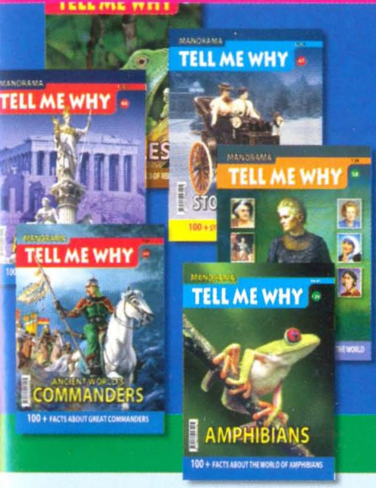
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